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МЕТОДОЛОГІЧНІ ЗАСАДИ ФУНКЦІОНАЛЬНОЇ СПЕЦІАЛІЗАЦІЇ ТЕХНІЧНОГО НАГЛЯДУ В УМОВАХ ЦИФРОВІЗАЦІЇ БУДІВНИЦТВА

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METHODOLOGICAL FOUNDATIONS OF FUNCTIONAL SPECIALIZATION IN TECHNICAL SUPERVISION UNDER THE CONDITIONS OF CONSTRUCTION DIGITALIZATION

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Анотація

У статті здійснено комплексне наукове обґрунтування необхідності трансформації системи технічного нагляду в Україні в умовах масштабної післявоєнної відбудови. Авторами доведено, що традиційна модель «універсального» інженера технічного нагляду не відповідає зростаючій технологічній складності об'єктів будівництва, що призводить до фрагментарності контролю та підвищення ризиків виникнення прихованих дефектів. У роботі запропоновано перехід до матричної моделі функціональної спеціалізації, яка базується на розподілі обов'язків між профільними інженерами технічного нагляду за трьома стратегічними векторами: конструктивної безпеки та надійності споруд, інженерних мереж та санітарно-технічних систем, а також енергетичної ефективності та комплексних систем автоматизації.

Особливу увагу приділено організаційно-технологічній взаємодії спеціалізованих груп із Єдиною державною електронною системою у сфері будівництва (ЄДЕССБ). У межах дослідження сформульовано концепцію впровадження багаторівневих протоколів доступу, що дозволяє забезпечити персональну відповідальність кожного фахівця за верифікацію даних у межах його професійної компетенції. Визначено роль допоміжного персоналу у забезпеченні безперервності формування «цифрового двійника» достовірними первинними даними. Результати дослідження підтверджують, що впровадження спеціалізованого підходу дозволяє суттєво підвищити якість верифікації спеціальних видів робіт та гарантувати відповідність фактичних параметрів безпеки складних інженерних систем проектним значенням, що є критично важливим для відновлення промислової та критичної інфраструктури України.

Abstract

The article provides a comprehensive scientific justification for the necessity of transforming the technical supervision system in Ukraine amidst large-scale post-war reconstruction. The authors demonstrate that the traditional "universal" model of a technical supervision engineer no longer meets the increasing technological complexity of construction projects, leading to fragmented control and higher risks of latent defects. The study proposes a transition to a matrix model of functional specialization based on the distribution of responsibilities among specialized technical supervision engineers across three strategic vectors: structural safety and reliability, engineering networks and sanitary systems, and energy efficiency and integrated automation systems.

Particular attention is paid to the organizational and technological interaction of specialized groups with the Unified State Electronic System in the Construction Sector (USESCS). Within the research, the concept of implementing multi-level access protocols is formulated, ensuring the personal responsibility of each specialist for data verification within their professional competence. The role of support staff in ensuring the continuity of "digital twin" formation with reliable primary data is defined. The research results confirm that implementing a specialized approach significantly improves the quality of verification for specialized types of work and guarantees the compliance of actual safety parameters of complex engineering systems with design values, which is critically important for the restoration of Ukraine's industrial and critical infrastructure.

Ключові слова: технічний нагляд, спеціалізація інженерів технічного нагляду, матрична модель управління, конструктивна надійність, інженерні системи, автоматизація будівництва, енергоефективність, управління якістю, цифровізація будівництва.

Keywords: Technical supervision, specialization of technical supervision engineers, matrix management model, structural reliability, engineering systems, building automation, energy efficiency, quality management, digitalization of construction.

Постановка проблеми

Сьогодні будівельна галузь України постає перед подвійним викликом: необхідністю масштабного відновлення зруйнованої інфраструктури та одночасним впровадженням сучасних інтелектуальних систем. Сучасні будівельні об’єкти від житлових комплексів до складних промислових підприємств перетворилися на високотехнологічні системи. У них надійна архітектура поєднується з автоматизованим управлінням, енергоефективністю та складними системами безпеки.

Проте існуюча нормативно-правова та організаційна модель технічного нагляду залишається жорстко обмеженою «універсальним» підходом. Згідно з поточною практикою, один сертифікований інженер з технічного нагляду делегується для контролю всього спектру будівельних робіт – від земляних до монтажу та пусконалагодження складних мікропроцесорних систем автоматизації чи пожежогасіння. Слід зауважити, що дорожня галузь України вже зробила крок до подолання цієї універсальності, запровадивши спеціалізований технічний нагляд, що враховує специфіку лінійних об'єктів та дорожнього будівництва. Однак у сфері цивільного та промислового будівництва підхід до технічного нагляду залишається уніфікованим, без належної функціональної спеціалізації фахівців. При цьому, обсяг нормативної інформації для різних видів будівельних робіт настільки великий, що один фахівець фізично не здатний володіти глибокою експертизою в кожному сегменті. Це призводить до поверхневого контролю складних вузлів, що робить саму процедуру здійснення технічного нагляду формальною та підвищує ризик відмови складних інженерних систем, що особливо критично для об’єктів із високим рівнем автоматизації.

Таким чином, виникає гостра науково-практична потреба у розробці та обґрунтуванні моделі професійної спеціалізації технічного нагляду. Необхідно перейти від лінійної структури контролю до матричної, де за кожним технологічним кластером закріплений фахівець відповідного профілю.

Аналіз останніх досліджень

Аналіз вітчизняних праць свідчить, що більшість авторів фокусуються на загальних аспектах цифровізації та правового регулювання галузі. Зокрема, досліджуються механізми взаємодії учасників будівництва в межах електронних систем та питання юридичної відповідальності інженерів [1,2] . Проте проблема професійної спеціалізації фахівців як інструменту управління якістю залишається недостатньо висвітленою.

Сучасні закордонні дослідження все частіше розглядають технагляд як складну мультидисциплінарну систему, де саме функціональна спеціалізація є ключем до забезпечення якості. Так, у праці [3] технагляд визначається як спеціалізована функція, що потребує інтегрованої співпраці різних інженерних дисциплін, зокрема через необхідність глибокої експертизи в межах структурного інжинірингу (нагляд за фундаментами, каркасами тощо). Крім того, у межах концепції «Industry 4.0» автори видання [4] пропонують стратегічні «дорожні карти» впровадження цифрових технологій для підвищення ефективності нагляду.

Особливої уваги потребує вивчення передового міжнародного досвіду, закріпленого, зокрема, у Міжнародному будівельному кодексі (International Building Code, IBC) [5], вказує на те, що світова практика вже давно базується на принципі диференційованого контролю. Відповідно до положень IBC, проведення спеціальних інспекцій (Special Inspections) довіряється виключно фахівцям, які підтвердили свою компетентність у конкретних вузькоспеціалізованих галузях: від контролю сталевих та бетонних конструкцій до перевірки складних механічних та електричних компонентів. Такий підхід прямо суперечить існуючій в Україні практиці універсального технічного нагляду і підтверджує, що для забезпечення надійності складних об'єктів необхідне залучення фахівців з відповідною вузькою сертифікацією для кожного типу робіт.

Мета досліджень

Обгрунтувати та розробити організаційно-технологічну модель спеціалізованого технічного нагляду, яка відповідає сучасним викликам відновлення промислової та цивільної інфраструктури України.

Методика досліджень

Методологія дослідження базується на застосуванні системного підходу до аналізу організаційної структури управління якістю в будівництві. Основу наукового пошуку становить метод організаційного моделювання, за допомогою якого обґрунтовано перехід від лінійної до матричної структури підпорядкування персоналу технічного нагляду. Це дозволило розробити модель функціонального розділення компетенцій залежно від технологічної складності об’єкта.

Виклад основного матеріалу

Сучасне будівництво, особливо в контексті відновлення зруйнованої промислової інфраструктури, вимагає контролю за декількома різними технологічними процесами одночасно. Традиційна модель, де один інженер здійснює нагляд за всіма розділами проекту, створює ситуацію, за якої увага фахівця розпорошується між загальнобудівельними роботами та високотехнологічним обладнанням.

Вирішення цієї проблеми лежить у площині впровадження моделі функціональної спеціалізації, яка передбачає розчленування загального процесу нагляду на три автономні, але взаємопов’язані вектори: конструктивний, інженерний та енерго-автоматичний (Таблиця 1). Кожен вектор очолюється профільним фахівцем, чия компетенція підтверджена відповідним досвідом та спеціалізацією, що

нівелює ризики, характерні для універсальної моделі нагляду».

Таблиця 1

Деталізація функціональних обов'язків фахівців технічного нагляду за векторами спеціалізації

№ п/п	Функціональний вектор технічного нагляду	Функції, що покладаються на інженера з технічного нагляду відповідно до його спеціалізації
1	Конструктивний (конструктивної безпеки та надійності)	Контроль за основними несучими та огороджувальними конструкціями, фундаментами, гідроізоляцією та вхідний контроль якості будівельної продукції
2	Інженерний (інженерних мереж та санітарно-технічних систем)	Нагляд за герметичністю трубопроводів, монтажем котельного та насосного обладнання, випробуванням систем під тиском та дотриманням санітарно-гігієнічних вимог
3	Енерго-автоматичний (енергетичної ефективності та систем автоматизації)	Контроль електропостачання, систем протипожежного захисту, засобів вимірювальної техніки (ЗВТ), систем «розумний дім» та пусконалагодження складних алгоритмів управління

Вектор конструктивної безпеки та надійності складає фундамент запропонованої моделі. У межах цього напряму основна увага фокусується на забезпеченні геометричної незмінності та тривалої міцності несучих систем. Експертний контроль у межах конструктивного вектора дозволяє фіксувати зміни в напружено-деформованому стані каркаса після циклічних або динамічних навантажень, забезпечуючи перевірку відповідності фактичних параметрів жорсткості вузлів сполучення проектним значенням. Такий підхід гарантує безпечну експлуатацію відновленого об’єкта протягом усього розрахункового терміну служби.

Другим невід’ємним елементом є вектор інженерних мереж та санітарно-технічних систем. У сучасних промислових та цивільних об’єктах вартість та складність внутрішніх мереж часто дорівнює вартості конструктивної частини. Спеціалізація в цьому напрямі дозволяє забезпечити реальний контроль за герметичністю систем, коректністю монтажу складного насосного та теплотехнічного обладнання. Інженер цього профілю концентрується на специфічних випробуваннях під тиском, дотриманні ухилів трубопроводів та забезпеченні належної пропускної здатності мереж. Універсальний інженер технічного нагляду зазвичай звертає увагу на факт монтажу, тоді як профільний фахівець оцінює технологічну логіку системи, запобігаючи виникненню прихованих дефектів, які проявляються лише під час пікових експлуатаційних навантажень.

Особливого значення в умовах відбудови набуває вектор енергетичної ефективності та систем автоматизації. Цей напрям відповідає за складову об’єкта, яка безпосередньо впливає на його безпеку та економічну доцільність. Функціонал фахівця тут охоплює нагляд за влаштуванням електротехнічних мереж, систем пожежного захисту та засобів автоматизованого управління будівлею. Ключовим аспектом діяльності є участь у комплексних пусконалагоджувальних роботах та перевірка алгоритмів взаємодії різних систем. Без спеціалізованого нагляду в цій зоні виникає ризик формального підписання актів на системи, працездатність яких не була фактично перевірена через брак специфічних знань універсального інженера з технічного нагляду. Спеціалізація дозволяє гарантувати, що автоматика об’єкта спрацює коректно в екстремальних ситуаціях, а системи обліку ресурсів забезпечать задекларований рівень енергоефективності.

Окрім того, важливим організаційним доповненням до системи векторів є запровадження ролі допоміжного персоналу. Наукове обґрунтування цієї потреби базується на аналізі витрат робочого часу висококваліфікованих інженерів. Встановлено, що значна частина ресурсів витрачається на технічні операції: фотофіксацію, ведення журналів, збір сертифікатів. Передача цих функцій допоміжному персоналу дозволяє спеціалізованим інженерам зосередитися виключно на експертній діяльності та перевірці критичних вузлів. Допоміжний персонал при цьому виконує функцію неперервного моніторингу на майданчику, що нівелює проблему «фрагментарної присутності» нагляду, характерну для поточної практики будівництва.

Запропонована модель (Рисунок 1) передбачає впровадження матричної структури управління командою технічного нагляду. Зазначена модель забезпечує перехід від універсального підходу до системи профільного технічного нагляду з персоналізованою відповідальністю кожного фахівця.

Загальне управління процесом технічного нагляду здійснює головний інженер технічного нагляду, який виконує функції керівника проекту технагляду. Головний інженер забезпечує координацію діяльності профільних інженерів, організовує взаємодію між учасниками будівельного процесу, аналізує результати перевірок та приймає узагальнені рішення за результатами технічного нагляду.

Головний інженер технагляду несе відповідальність за повноту охоплення перевірками всіх напрямів будівельних робіт, а також за своєчасність і коректність фіксації результатів у цифровій системі.

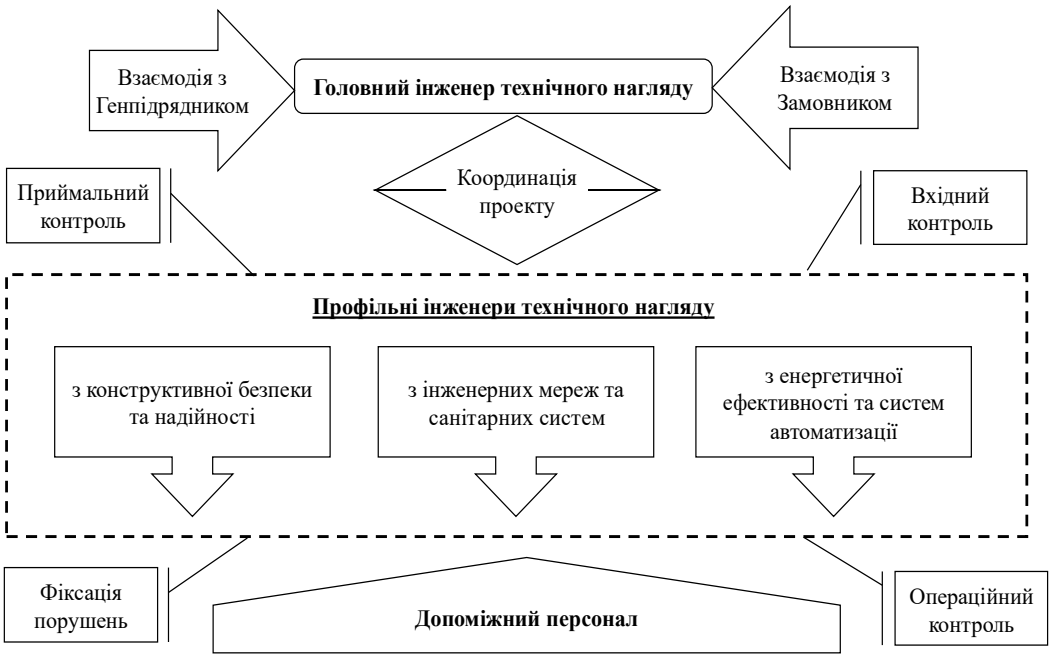

Рисунок 1 – Організаційно-функціональна модель координації спеціалізованого технічного нагляду

Процес нагляду за новою моделлю виглядає як послідовний ланцюг перевірок. Допоміжний персонал виконує первинну фіксацію робіт. Якщо робота належить до категорії високого ризику (наприклад, монтаж електрощитової), дані передаються спеціалізованому інженеру-енергетику. Після його підтвердження, Головний інженер технічного нагляду акцептує етап.

Такий підхід створює «систему потрійного фільтра», де помилка на одному рівні обов'язково виявляється на наступному. Особливо ефективною ця модель є при відбудові складних промислових об’єктів, де відновлення технологічних ліній вимагає специфічних знань, якими не володіє інженер загальнобудівельного профілю.

Таким чином, запропонована організаційно-технологічна модель формує багаторівневу структуру контролю. Вона базується на чіткому розподілі відповідальності за технологічними напрямками, що дозволяє уникнути професійного перевантаження персоналу та підвищити точність виявлення дефектів. Матричний підхід до формування команд технагляду дає змогу гнучко адаптувати склад групи під поточні потреби будівництва, залучаючи потрібну експертизу саме в моменти активізації відповідних робіт. Така трансформація є критично необхідною для гарантування якості відбудови інфраструктури України, перетворюючи технічний нагляд на науково обґрунтовану систему управління надійністю та безпекою.

Особливе місце в реалізації моделі функціональної спеціалізації посідає механізм взаємодії команди технічного нагляду з Єдиною державною електронною системою у сфері будівництва (ЄДЕССБ). В умовах повної цифровізації дозвільних та контрольних процедур, технічний нагляд перестає бути лише інструментом фізичного контролю на майданчику, трансформуючись у ключову ланку формування «цифрового двійника» об’єкта. Проте існуючий функціонал електронних кабінетів технагляду, орієнтований на одного користувача (підписанта), створює бар'єри для ефективної командної роботи фахівців різного профілю.

Впровадження спеціалізованих векторів контролю вимагає модернізації логіки роботи в ЄДЕССБ шляхом створення багаторівневих протоколів доступу. Запропонована модель (Рисунок 2) передбачає, що кожен профільний фахівець несе персональну відповідальність за верифікацію даних у межах своєї компетенції в системі. Це дозволяє уникнути ситуації, коли головний інженер технагляду підписує електронним підписом акти за спеціалізовані розділи (наприклад, пусконалагодження систем автоматизації), не маючи можливості реально перевірити достовірність завантажених даних.

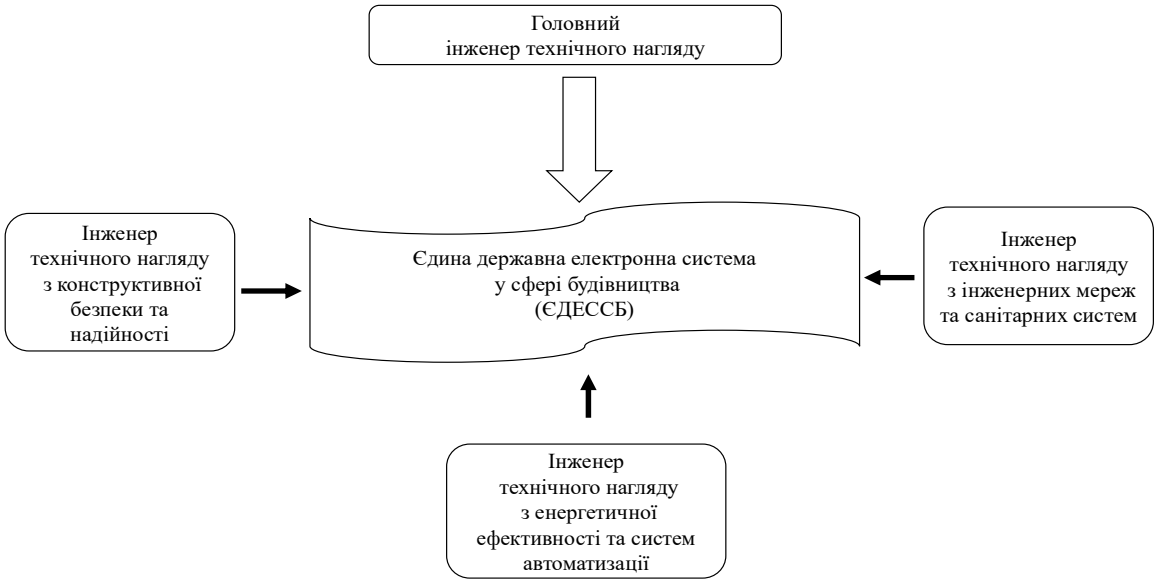

Рисунок 2 – Функціональна модель інформаційної взаємодії фахівців технічного нагляду за напрямами спеціалізації в інформаційному середовищі ЄДЕССБ

Така інтеграція спеціалізованого технічного нагляду в державну інформаційну систему забезпечує прозорість процесу відбудови для всіх стейкхолдерів. У разі виникнення дефектів під час експлуатації, архітектура даних у ЄДЕССБ дозволятиме чітко ідентифікувати, який саме профільний фахівець проводив перевірку конкретного вузла. Це не лише підвищує персональну відповідальність інженерів, а й створює нові стандарти якості для об'єктів критичної інфраструктури, де поєднання вузькоспеціалізованих знань із цифровими інструментами стає єдиною гарантією надійності результату.

Висновки

За результатами дослідження встановлено, що існуюча модель універсального технічного нагляду не відповідає сучасним вимогам безпеки при відбудові складних об’єктів. Обґрунтовано, що впровадження матричної моделі спеціалізації дозволяє підвищити якість контролю за рахунок концентрації вузькопрофільної експертизи на критичних технологічних етапах.

Доведено доцільність розподілу персоналу за трьома основними напрямками у поєднанні з ієрархічною структурою, де інженери нижчої спеціалізації виконують рутинні функції, а вищої спеціалізації – узагальнення та експертні заключення. Такий підхід мінімізує вплив «людського фактора» та забезпечує багаторівневу верифікацію технологічних процесів. Практичне значення запропонованої спеціалізації полягає у створенні надійної організаційної бази для відновлення складних промислових та інфраструктурних об'єктів, де ціна технічної помилки є критичною.

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ART STUDIES

THE ROLE OF PRAGMATICS AND RHETORIC IN CONSTRUCTING AUTHORITY AND TRUST IN INSTITUTIONAL PUBLIC COMMUNICATION: THE CASE OF THE FACULTY OF FOREIGN LANGUAGES

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Abstract

This study explores the role of pragmatics and rhetoric in the construction of institutional authority and trust in public communication, using the Faculty of Foreign Languages as a case study. It investigates how institutional discourse, expressed through official announcements and the dissemination of academic and cultural activities, functions as a strategic mechanism for legitimizing authority, shaping institutional identity, and fostering trust among students and the wider public. The corpus comprises institutional texts published on the faculty's official website and Facebook page during the period from November 2025 to December 2025.

The study adopts a qualitative discourse-analytical approach that integrates pragmatic and rhetorical perspectives. Pragmatic analysis focuses on the identification of speech acts, modality, and the relationship between the institution and its audiences, while rhetorical analysis examines the use of ethos, logos, and pathos in institutional messaging. This combined framework enables a comprehensive examination of how linguistic choices contribute to communicative effectiveness and institutional credibility.

The findings reveal that institutional authority is primarily constructed through informational clarity, mitigated directives, and the consistent use of formal and impersonal language. Trust is reinforced through transparency, coherence, and the emphasis on academic competence and professional reliability. From a rhetorical perspective, ethos emerges as the dominant strategy, supported by logos through factual details, deadlines, and structured content, while pathos is employed in a controlled and limited manner, mainly in cultural and commemorative communication. Additionally, the analysis highlights stylistic differences across communication channels, with website announcements displaying higher levels of formality and standardization, whereas Facebook posts allow for moderate emotional engagement and increased audience interaction.

Overall, the study demonstrates that the interplay between pragmatic and rhetorical strategies plays a crucial role in enhancing the credibility, legitimacy, and effectiveness of institutional public communication in higher education contexts.

Keywords: Institutional communication, pragmatics, rhetoric, discourse analysis.

I. Introduction

Institutional communication plays a central role in shaping the identity, credibility, and legitimacy of organizations, particularly within higher education contexts. Universities and faculties are not only sites of teaching and research but also complex institutions that engage in continuous interaction with multiple audiences, including students, academic staff, administrative personnel, policy makers, and the wider public. Through official announcements, public statements, and media communications, institutions construct meanings, convey values, and regulate relationships with their audiences. Language, therefore, becomes a strategic resource through which institutions present themselves as authoritative, reliable, and trustworthy actors within society (Cornelissen, 2017).

In the context of higher education, authority and trust are essential components of effective institutional communication. Faculties are expected to function as credible sources of knowledge, professional guidance, and academic governance. The way information is communicated, what is said, how it is said, and to whom, directly influences how institutional actions and decisions are perceived. A lack of clarity, inappropriate tone, or inconsistent messaging can undermine institutional authority and weaken public trust, while transparent, coherent, and professionally framed discourse can strengthen legitimacy and reinforce confidence in the institution (Castells, 2013). This is particularly relevant in contemporary academic environments, where communication increasingly occurs through digital platforms that demand immediacy, accessibility, and public accountability.

The research problem addressed in this study lies in understanding how institutional authority and trust are discursively constructed rather than assumed. Authority is no longer based solely on formal hierarchy or institutional status; instead, it is continuously negotiated through communicative practices. Trust, similarly, is built through repeated interactions that demonstrate competence, reliability, and ethical responsibility. In this sense, institutional discourse does not merely transmit information but actively shapes perceptions, expectations, and relationships between the faculty and its audiences. Analyzing these discursive mechanisms is therefore crucial for understanding how higher education institutions maintain credibility in a competitive and highly visible public sphere (Hyland, 2018).

The aim of this study is to examine how pragmatic and rhetorical strategies contribute to the construction

of authority and trust in institutional public communication. By combining a pragmatic analysis of speech acts, modality, and audience positioning with a rhetorical analysis of ethos, logos, and pathos, the study seeks to provide a comprehensive account of how institutional meaning is produced and negotiated. Pragmatics allows for an exploration of how communicative intentions are realized through specific linguistic choices, while rhetoric highlights the persuasive dimensions through which institutions legitimize their role and reinforce their credibility (Meyer, 2009). The integration of these two perspectives offers a nuanced framework for analyzing institutional discourse in higher education.

The study focuses on the public communication of the Faculty of Foreign Languages during the period from November 2025 to December 2025. This timeframe encompasses a wide range of institutional activities, including academic events, training programs, research initiatives, commemorative messages, and administrative announcements. By examining communication published on the faculty's official website and social media platforms, the study captures both formal and semi-formal institutional discourse, providing insight into how authority and trust are constructed across different communicative contexts and channels.

2. Theoretical framework

2.1 Institutional Communication

Institutional communication refers to the structured and strategic use of language through which organizations represent themselves, convey information, and regulate relationships with their internal and external audiences. In higher education contexts, institutional communication encompasses official announcements, policy statements, academic reports, promotional materials, and public engagement through digital platforms. Its primary function is not only to inform but also to construct institutional identity, legitimacy, and coherence, ensuring consistency between institutional values, actions, and public representation (Cornelissen, 2017).

The significance of institutional communication in universities lies in its capacity to mediate complex interactions between multiple stakeholders, including students, academic staff, administrative bodies, and society at large. As knowledge-producing institutions, universities are expected to uphold standards of transparency, professionalism, and accountability. Effective institutional communication supports these expectations by providing clear, reliable, and ethically framed messages that reinforce organizational stability and credibility (Castells, 2013). In this sense, communication functions as a governance tool that shapes perceptions and guides behavior within academic communities.

Universities operate as authoritative and credible communicative actors due to their institutional mandate and epistemic role in society. Authority is constructed through formal discourse, expert positioning, and the consistent use of standardized communicative practices. Credibility, in turn, is reinforced through clarity, accuracy, and the demonstration of academic competence. Through repeated and coherent communicative acts, universities establish trust and legitimacy, positioning themselves as reliable sources of knowledge and guidance in both national and international contexts (Hyland, 2018).

2.2 Pragmatics in Institutional Communication

Pragmatics is concerned with the study of language in use and with how meaning is constructed through context, speaker intention, and interaction between communicative participants. In institutional communication, pragmatics provides a valuable analytical lens for understanding how official messages function beyond their literal content, revealing how institutions manage authority, responsibility, and social relations through language (Levinson, 1983). Institutional discourse is inherently goal-oriented, and pragmatic choices play a central role in achieving communicative effectiveness while maintaining professionalism and legitimacy.

A key pragmatic dimension in institutional communication is the use of speech acts. Universities regularly employ speech acts such as announcements, directives, invitations, recommendations, and clarifications to organize academic life and guide stakeholder behavior. These acts are often strategically mitigated to preserve institutional authority without appearing coercive, particularly when addressing students or the general public (Searle, 1979). Modal expressions, impersonal constructions, and formal registers are commonly used to balance institutional power with politeness and inclusivity.

Another central aspect of pragmatics in institutional discourse is the management of the speaker–recipient relationship. Institutions typically position themselves as collective, impersonal entities, using inclusive language to reduce social distance and foster cooperation. Through pragmatic strategies such as indirectness, hedging, and audience-sensitive framing, universities seek to ensure clarity while maintaining trust and respect. Consequently, pragmatic analysis reveals how institutional communication functions as a negotiated process in which authority is enacted discursively rather than imposed explicitly (Thomas, 1995).

2.3 Rhetoric in Institutional Communication

Rhetoric plays a fundamental role in institutional communication by shaping how messages persuade, legitimize, and reinforce authority within the public sphere. In higher education contexts, rhetorical strategies are employed not to manipulate audiences, but to construct credibility, coherence, and trust through carefully framed discourse. Institutional rhetoric is therefore closely linked to the strategic presentation of knowledge, values, and professional identity (Meyer, 2009).

A central rhetorical framework in institutional communication is Aristotle's triad of ethos, logos, and pathos. Ethos refers to the construction of institutional credibility and moral authority, often achieved through references to academic expertise, institutional achievements, and alignment with recognized standards. Universities primarily rely on ethos to position themselves as competent and trustworthy communicative actors. Logos, on the other hand, involves rational argumentation and the structured presentation of information,

such as data, deadlines, regulations, and procedural explanations. This logical framing reinforces transparency and supports informed decision-making among audiences (Hyland, 2018).

Pathos, although less prominent in academic institutional discourse, is strategically employed in controlled and restrained forms. Emotional appeals are typically limited to cultural, commemorative, or celebratory contexts, where they serve to strengthen identification and solidarity without undermining institutional neutrality. Through the balanced integration of ethos, logos, and pathos, institutional rhetoric contributes to the legitimization of authority and the reinforcement of trust, ensuring that communication remains persuasive, professional, and socially responsible (Charteris-Black, 2011).

3. Methodology

This study adopts a qualitative discourse-analytical methodology to investigate how institutional authority and trust are constructed through pragmatic and rhetorical strategies in public communication. The methodological design is guided by the assumption that institutional discourse does not merely transmit information but actively shapes social relations, identities, and perceptions through language choices situated in specific communicative contexts (Fairclough, 1995). By integrating pragmatic and rhetorical analysis, the study provides a comprehensive examination of how meaning, persuasion, and legitimacy are discursively produced in higher education communication.

3.1 Corpus

The corpus consists of official institutional announcements and representations of academic, cultural, and administrative activities published as media communications by the Faculty of Foreign Languages. These texts include administrative notices, calls for participation, training and professional development announcements, conference and workshop reports, commemorative messages, promotional posts, and informational updates related to research projects and institutional initiatives. Both text-only posts and multimodal posts accompanied by images are included, while the analysis focuses primarily on the linguistic content of the messages.

The selected corpus reflects a broad spectrum of institutional communication genres, allowing for the identification of recurring pragmatic and rhetorical patterns across different communicative purposes. This diversity ensures analytical representativeness and supports the examination of authority and trust across formal, semi-formal, and public-facing institutional discourse.

3.2 Period of Analysis

The temporal scope of the study covers the period from November 2025 to December 2026, a timeframe that encompasses the beginning of the academic year, periods of intensified academic activity, and key institutional events. This period is particularly relevant, as it includes high-frequency communication related to academic organization, research dissemination, professional training, and public engagement. Analyzing communication across this timeframe enables the observation of consistency and variation in institutional discourse over time.

3.3 Communication Channels

The data were collected from two primary communication channels:

1. the faculty's official website, and
2. the faculty's official Facebook page.

These platforms represent distinct yet complementary modes of institutional communication. The official website primarily serves as a formal and authoritative channel for standardized information, while Facebook enables more immediate, interactive, and publicly visible communication. Examining both channels allows for a comparative perspective on how pragmatic and rhetorical strategies are adapted to different audiences and communicative environments (Hyland, 2018).

3.4 Analytical Approach

The analysis combines pragmatic and rhetorical approaches to institutional discourse. Pragmatic analysis focuses on the identification of speech acts (e.g., announcements, directives, invitations, recommendations, clarifications), modality, mitigation strategies, and the construction of the institution–audience relationship (Searle, 1979; Thomas, 1995). Rhetorical analysis examines the use of ethos, logos, and pathos in the construction of institutional credibility, authority, and trust (Meyer, 2009).

The analytical process involves close reading, categorization of communicative functions, and interpretation of linguistic choices within their institutional and social context. This integrated approach allows for a nuanced understanding of how authority and trust emerge through the interaction of pragmatic intent and rhetorical framing.

3.5 Research Questions

The study is guided by the following research questions:

1. How does the Faculty of Foreign Languages employ pragmatic strategies to construct institutional authority and trust in public communication?
2. Which rhetorical strategies (ethos, logos, pathos) are most prominently used in institutional announcements and media communications?
3. How do pragmatic and rhetorical dimensions interact to enhance the effectiveness of institutional public discourse?
4. Are there identifiable differences in pragmatic and rhetorical strategies between communication published on the official website and Facebook page?

IV. Analysis

4.1 Pragmatic Analysis

The pragmatic analysis focuses on how institutional meaning is constructed through speech acts, modality, and the management of the relationship between the institution and its public. The official announcements and media communications of the Faculty of Foreign Languages reveal a systematic use of language that prioritizes clarity, professionalism, and institutional authority while maintaining a cooperative and inclusive tone.

A prominent pragmatic feature of the corpus is the dominance of **assertive and directive speech acts,** particularly announcements, invitations, recommendations, and clarifications. Announcements are primarily used to convey factual information related to academic events, deadlines, training programs, and institutional initiatives. Invitations frequently appear in posts promoting conferences, workshops, and cultural activities, functioning to encourage participation without imposing obligation. Recommendations are often implemented through benefit-oriented formulations, while clarifications are used to manage changes, deadlines, or procedural updates, thereby reducing uncertainty and reinforcing transparency.

Modality plays a crucial role in shaping institutional authority. Directives are typically mitigated through modal verbs, impersonal constructions, and polite formulations, which soften institutional power while preserving legitimacy. Expressions such as *"participants are invited to"*, *"registration is open"*, or *"students are encouraged to"* exemplify a preference for indirectness and non-coercive guidance. Informational content is structured in a concise and explicit manner, often supported by dates, locations, and procedural details, reinforcing reliability and predictability.

The institution vs public relationship is constructed through an inclusive and professional communicative stance. The faculty positions itself as an authoritative yet supportive entity, addressing students and the wider public as partners in academic life rather than passive recipients. Collective and impersonal references emphasize institutional unity, while audience-oriented framing fosters cooperation and trust.

Table 1.

Pragmatic Features in FGJH Institutional Communication

Pragmatic Dimension	Linguistic Realization	Communicative Function
Speech acts	Announcements, invitations, recommendations, clarifications	Organization of academic and institutional activities
Modality	Mitigated directives, modal verbs, impersonal forms	Preservation of authority without coercion
Informational structure	Clear dates, locations, procedures	Transparency and predictability
Institution–public relation	Inclusive, professional tone	Trust-building and cooperative engagement

4.2 Rhetorical Analysis

The rhetorical analysis examines how institutional authority and trust are constructed through persuasive strategies in the public communication of the Faculty of Foreign Languages. Rather than relying on overt persuasion, the faculty employs a restrained and professional rhetorical style that aligns with the norms of academic institutional discourse. The analysis is structured around the classical rhetorical triad of ethos, logos, and pathos.

Ethos emerges as the dominant rhetorical strategy across the corpus. Institutional credibility is constructed through references to academic expertise, institutional roles, research projects, conferences, partnerships, and professional achievements. The frequent mention of academic titles, departments, international collaborations, and recognized programs positions the Faculty as a competent and authoritative actor in the field of higher education. This consistent emphasis on expertise and institutional responsibility reinforces trust and legitimizes the Faculty's communicative authority.

Logos is employed through rational argumentation and the structured presentation of information. Institutional messages are typically organized around clear factual elements such as dates, locations, objectives, benefits, and outcomes. In training and project-related announcements, logical sequencing is used to explain what participants will learn, what they will gain, and how activities contribute to academic or professional development. This rational framing supports transparency and enables audiences to make informed decisions, further strengthening institutional credibility.

Pathos plays a limited but strategic role in the corpus. Emotional appeals are carefully controlled and primarily appear in commemorative, cultural, or celebratory posts, such as national holidays, literary events, or student achievements. In these contexts, positive emotions such as pride, unity, and inspiration are evoked without compromising institutional neutrality. Administrative and academic announcements largely avoid emotional language, maintaining a calm and objective tone.

Overall, the balanced integration of ethos, logos, and restrained pathos allows the faculty to communicate effectively while preserving professionalism, authority, and trust.

Table 2.

Rhetorical Strategies in FGJH Institutional Communication

Rhetorical Strategy	Linguistic Indicators	Communicative Purpose
Ethos	Academic titles, institutional affiliations, research references	Construction of authority and credibility
Logos	Factual details, structured information, clear objectives	Transparency and rational persuasion
Pathos	Controlled emotional language in cultural posts	Identification, solidarity, and engagement
Rhetorical balance	Dominance of ethos and logos	Maintenance of institutional professionalism

4.3 Rhetorical Analysis

The rhetorical dimension of the Faculty of Foreign Languages' institutional communication plays a crucial role in reinforcing authority and building trust through carefully calibrated persuasive strategies. The construction of institutional ethos is central to this process. Ethos is established through explicit references to academic expertise, institutional roles, research activities, international collaborations, and professional achievements. The frequent use of academic titles, department names, and project affiliations positions the Faculty as a knowledgeable, responsible, and credible actor within the higher education landscape.

The use of logos is evident in the rational organization of information and the emphasis on factual clarity. Institutional messages consistently present concrete details such as dates, locations, objectives, benefits, and procedural steps. Logical sequencing and reference to recognized programs, projects, and funding opportunities enhance transparency and support informed decision-making, thereby strengthening trust in institutional communication.

Pathos is employed in a restrained and controlled manner. Emotional language is largely absent from administrative and academic announcements, ensuring neutrality and professionalism. When present, emotional appeal is limited to cultural, commemorative, or celebratory contexts, where calm and positive emotions such as pride, unity, and inspiration are evoked without undermining institutional objectivity.

Finally, the rhetoric of success and credibility is constructed through the regular presentation of achievements, successful events, completed projects, and academic outcomes. This success-oriented discourse reinforces the faculty's image as an effective, reliable, and forward-looking institution.

Table 3.

Rhetorical Strategies and Functions in FGJH Communication

Rhetorical Element	Linguistic Features	Communicative Function
Ethos	Academic titles, institutional roles, project references	Construction of authority and credibility
Logos	Structured information, factual details, references	Rational persuasion and transparency
Pathos	Controlled emotional tone, symbolic language	Identification and engagement
Rhetoric of success	Achievement-oriented discourse	Reinforcement of trust and institutional image

4.4 Interplay Between Pragmatics and Rhetoric

The construction of institutional authority and trust in the public communication of the Faculty of Foreign Languages is achieved through the dynamic interaction between pragmatic and rhetorical strategies. Pragmatics provides the functional framework through which institutional intentions are realized, while rhetoric shapes the persuasive force and credibility of these communicative acts. Together, they form a cohesive discursive mechanism that enhances communicative effectiveness.

From a pragmatic perspective, speech acts such as announcements, invitations, recommendations, and clarification's structure institutional interaction by defining roles, expectations, and procedures. These acts are frequently mitigated through modality and impersonal constructions, allowing the institution to exercise authority without overt coercion. Rhetorical strategies complement this pragmatic foundation by reinforcing credibility and legitimacy. Ethos strengthens the institutional voice by highlighting expertise and professionalism, while logos supports clarity and rational understanding through structured and factual content. Pathos, when employed, is carefully regulated to avoid emotional excess and to maintain institutional neutrality.

The interaction between pragmatics and rhetoric significantly influences public perception. Pragmatic clarity ensures transparency and predictability, which fosters confidence and reduces uncertainty. Rhetorical coherence enhances identification with the institution and reinforces perceptions of competence and reliability. As a result, authority emerges not as imposed power but as a discursively negotiated outcome grounded in professionalism, consistency, and trust.

Table 4.

Interplay of Pragmatic and Rhetorical Strategies in Institutional Communication

Pragmatic Element	Rhetorical Strategy	Combined Effect on Authority and Trust
Speech acts (announcements, invitations)	Ethos	Legitimation of institutional authority
Mitigated directives	Logos	Transparent and rational guidance
Informational clarity	Logos	Reduction of uncertainty and increased trust
Audience-oriented framing	Pathos (controlled)	Engagement without loss of neutrality

V. Discussion and Conclusion

The present study set out to examine how pragmatic and rhetorical strategies contribute to the construction of authority and trust in institutional public communication, using the Faculty of Foreign Languages as a case study. The analysis demonstrates that institutional discourse functions not merely as a channel for information transmission, but as a strategic communicative practice through which legitimacy, credibility, and professional identity are continuously negotiated.

The findings reveal that authority is primarily constructed through pragmatic mechanisms such as the systematic use of speech acts, mitigated directives, and informational clarity. Announcements, invitations, recommendations, and clarifications dominate the corpus, reflecting the Faculty's role as an organizer and facilitator of academic life rather than an imposing authority. The consistent use of impersonal forms, modal expressions, and polite formulations allows the institution to guide behavior while maintaining a cooperative and inclusive relationship with its audience. These pragmatic choices reduce potential power asymmetries and contribute to the perception of transparency and reliability.

From a rhetorical perspective, the analysis confirms the central role of ethos in institutional communication. The faculty consistently presents itself as a competent and authoritative academic actor through references to expertise, academic achievements, research projects, and international collaborations. Logos further reinforces this credibility by structuring messages around factual details, logical sequencing, and explicit benefits for participants. Pathos is employed in a limited and controlled manner, primarily in cultural and commemorative contexts, where it serves to foster identification and solidarity without compromising institutional neutrality. Together, these rhetorical strategies support a discourse of professionalism, success, and trustworthiness.

These findings are largely consistent with existing literature on institutional and academic discourse, which emphasizes the importance of clarity, consistency, and credibility in the way that a specific institution communicates. Previous studies have highlighted that authority in contemporary institutions is increasingly discursive and relational rather than hierarchical. The present study contributes to this body of research by demonstrating how pragmatics and rhetoric interact at a micro-linguistic level to produce these effects in higher education contexts.

Despite its contributions, the study has certain limitations. The analysis is limited to a single faculty within one university and focuses on a specific time period. As a qualitative study, it does not measure audience reception directly, and interpretations are based on textual analysis rather than empirical feedback from communication recipients. Additionally, while multimodal elements were acknowledged, the primary focus remained on linguistic content.

In conclusion, this study shows that the effective interplay between pragmatic and rhetorical strategies is essential for building institutional authority and trust. The Faculty of Foreign Languages achieves communicative effectiveness through discursive professionalism, rational transparency, and controlled emotional engagement. The study contributes to the fields of stylistics and institutional communication by offering an integrated analytical framework that bridges pragmatics and rhetoric. Future research could expand the corpus to include multiple institutions, conduct comparative cross-cultural analyses, or incorporate audience reception studies to further explore how institutional discourse is interpreted and evaluated by different publics.

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CHEMISTRY SCIENCES

ИССЛЕДОВАНИЕ ВОЛЬТАМПЕРОМЕТРИЧЕСКОГО ПОВЕДЕНИЯ Re(VII) В СЕРНОКИСЛЫХ РАСТВОРАХ ДИМЕТИЛСУЛЬФОКСИДА И РАЗРАБОТКА МЕТОДИКИ ОПРЕДЕЛЕНИЯ РЕНИЯ В СПЛАВАХ

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INVESTIGATION OF VOLTAMMETRIC BEHAVIOR OF Re(VII) IN SULFURIC ACID DIMETHYLSULFOXIDE SOLUTIONS AND THE DEVELOPMENT OF THE TECHNIQUE FOR RHENIUM DETERMINATION IN ALLOYS

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Аннотация

Изучено вольтамперометрическое поведение рения(VII) в минерально-органических средах, содержащих серную кислоту и диметилсульфоксид. Найдено, что в области высоких концентраций компонентов фонового электролита рений(VII) необратимо восстанавливается на ртутном электроде с участием трех электронов, образуя хорошо выраженный максимум тока в области потенциалов от –0,40 до –0,45 В. Максимальный ток носит диффузионно-кинетический характер и линейно зависит от концентрации Re(VII) в растворе при его содержании от $1{,}5\cdot10^{-5}$ до $2{,}0\cdot10^{-3}$ моль/л, при этом на величину и форму электроаналитического сигнала деполяризатора не оказывают влияния ионы Al(III), Sc(III), Ti(IV), V(V), Cr(III), Mn(II), Fe(III), Co(II), Ni(II), Zr(IV), Nb(V), Ta(V), W(VI) и ряда других элементов. Разработана методика вольтамперометрического определения рения в металлических материалах, позволяющая вести одновременное определение содержания Re и W в тугоплавких сплавах «вольфрам-рений», отличающаяся чувствительностью, точностью и простотой аналитической процедуры.

Abstract

The voltammetric behavior of rhenium(VII) in mineral-organic media containing sulfuric acid and dimethylsulfoxide. It was found that in the region of high concentrations of background electrolyte components, rhenium(VII) is irreversibly reducted on a mercury electrode with the participation of three electrons, forming a well-defined current maximum in the potential range from –0,40 to –0,45 V. The maximum current is of a diffusion-kinetic nature and linearly depends on the concentration of Re(VII) in the solution at its content from $1{,}5\cdot10^{-5}$ to $2{,}0\cdot10^{-3}$ mol/l, while the magnitude and shape of the electroanalytical signal of the depolarizer are not affected by ions Al(III), Sc(III), Ti(IV), V(V), Cr(III), Mn(II), Fe(III), Co(II), Ni(II), Zr(IV), Nb(V), Ta(V), W(VI) and a number of other elements. A technique has been developed for the voltammetric determination of rhenium in metallic materials, which allows simultaneous determination of the Re and W contents in refractory tungsten-rhenium alloys, characterized by high sensitivity, accuracy and simplicity of the analytical procedure.

Ключевые слова: рений, вольтамперометрия, минерально-органические среды, анализ сплавов.

Keywords: rhenium, voltammetry, mineral-organic media, alloy analysis.

Введение

Рений как компонент металлических сплавов придает им специальные свойства, такие, как жаропрочность, тугоплавкость, пластичность, износостойкость, устойчивость к высокотемпературной коррозии и др. Данные свойства во многом зависят от соотношения основных компонентов сплавов (рения, вольфрама, молибдена), что требует применения прецизионных методов контроля этого соотношения. Среди физико-химических методов анализа и исследования химического состава материалов важное значение имеют электрохимические методы (вольтамперометрия, потенциометрия, кондуктометрия), обладающие достаточно низкими пределами обнаружения, высокой селективностью, точностью и простотой аппаратурного оформления [1].

Вольтамперометрическое поведение рения(VII) в водных растворах минеральных кислот описано в [2], показано, что рений(VII) восстанав-

ливается на ртутных электродах в достаточно широкой области потенциалов (от –0,1 В до –0,7 В) с образованием нескольких волн различной природы, величина и форма которых зависят от природы и концентрации ионов неорганического электролита. В щелочных электролитах авторы [3] наблюдали полярографические волны рения(VII) на ртутном капающем электроде в области потенциалов от –1,25 В до –1,75 В, форма которых, а также значения максимальных токов зависят от концентраций деполяризатора и фонового электролита. Электрохимическое восстановление рения(VII) на платиновом электроде в хлористоводороднокислых средах изучено в работе [4]. В данных условиях рений(VII) восстанавливается в несколько стадий, при этом максимальный ток имеет диффузионно-кинетическую природу. Сообщается об электрохимическом поведении рения(VII) на стеклоуглеродном электроде в присутствии ионов никеля(II) и четвертичных солей аммония (хлорида холина) [5], найдено, что рений(VII) в указанных условиях восстанавливается необратимо при диффузионном контроле предельного тока. Известен ряд методов вольтамперометрического определения рения с применением различных типов электродов и фоновых электролитов. В природных минералах и рудах предложено определять содержание рения по каталитическому току, наблюдаемому на ртутно-пленочном электроде в смеси растворов серной кислоты и пероксида водорода, при этом рений(VII) предлагается отделять от мешающих элементов дистилляцией [6]. Для определения рения в рудных концентратах разработана инверсионно – вольтамперометрическая методика с предварительным накоплением Re на золотографитовом электроде в растворе 1 М HCl [7]. В водных растворах природного и техногенного происхождения рений можно определять кинетическим инверсионно-вольтамперометрическим методом с предварительным концентрированием рения в виде ReO_2 на ртутно-пленочном электроде [8]. Известные методики определения рения, наряду с теми или иными преимуществами, зачастую не позволяют определять Re без отделения от сопутствующих элементов, требуют использования специально подготовленных рабочих электродов, а в ряде случаев весьма трудоемки. Ранее было показано [9], что использование в вольтамперометрии минерально-органических фоновых электролитов с высокой сольватирующей способностью обеспечивает получение селективных электроаналитических откликов при требуемой точности и чувствительности определения. Сведений о вольтамперометрическом поведении рения(VII) в таких средах в литературе не приводится. В данной работе изучено вольтамперометрическое поведение рения(VII) в сернокислых растворах диметилсульфоксида (ДМСО) и предложена методика определения рения в металлических материалах, позволяющая вести одновременное определение содержания рения и вольфрама в тугоплавких сплавах «вольфрам-рений».

Материалы и методы исследования

Вольтамперограммы растворов рения(VII) регистрировали на полярографе универсальном ПУ-1 в режиме линейной развертки потенциала при скорости сканирования поляризующего напряжения (v) от 0,1 до 1,0 В/с в области от –0,02 В до –1,20 В. Исследования проводили в трехэлектродной электрохимической ячейке, используя в качестве рабочего электрода ртутный капающий электрод (РКЭ) и насыщенный каломельный электрод в качестве электрода сравнения. Для элиминирования диффузионного потенциала использовали электролитический мостик, заполненный раствором фона. Рабочий раствор рения(VII) готовили растворением точной навески металлического Re в 2 М серной кислоте при нагревании. Электролиты для полярографирования получали смешением в мерной колбе емкостью 25 $см^3$ соответствующих аликвот раствора металла, серной кислоты и диметилсульфоксида. Все реактивы, используемые в работе, имели квалификацию «х.ч.».

Результаты исследования и их обсуждение

Установлено, что рений(VII) восстанавливается на РКЭ в концентрированных сернокислых растворах диметилсульфоксида в области потенциалов от –0,40 до –0,48 В, образуя пик тока, величина которого растет с увеличением содержания H_2SO_4 и ДМСО в электролите, достигая максимального значения в 5 М растворах, при этом потенциал электровосстановления Re(VII) сдвигается в область более отрицательных значений. Сравнение экспериментальных значений плотности катодного тока Re(VII) с рассчитанными по уравнениям для обратимых(1) и необратимых(2) процессов при значении n=3 (число электронов, принимающих участие в электродной реакции) свидетельствует о протекании необратимого восстановления рения(VII) в соответствии с общей схемой: $Re(VII) + 3e^- \rightarrow Re(4)$. Найдено, что максимальный катодный ток рения(VII) в данных условиях имеет диффузионно-кинетический характер (коэффициент Семерано составляет величину $0{,}32<X_v<0{,}42$) и линейно зависит от содержания деполяризатора в растворе в пределах от $1{,}5\cdot10^{-5}$ до $2{,}0\cdot10^{-3}$ моль/л Re(VII). Показано, что ионы Al(III), Sc(III), Ti(IV), V(V), Cr(III), Mn(II), Fe(III), Co(II), Ni(II), Zr(IV), Nb(V), Ta(V), W(VI) и ряда других элементов не оказывают влияния на значения потенциалов и токов восстановления рения(VII) в данных условиях. В таблице 1 приведены вольтамперометрические характеристики рения(VII) в сернокислых диметилсульфоксидсодержащих электролитах.

Таблица 1

Вольтамперометрические характеристики Re(VII) в сернокислых растворах диметилульфоксида (C_{Re} =$5\cdot10^{-4}$ моль/л, 7,0 М H_2SO_4)

Концентрация ДМСО, $C_{ДМСО}$ (моль/л)	Скорость сканирования потенциала, *v* (В/с)	Потенциал катодного пика тока, $-E_к$(В)	Плотность катодного тока, эксп., $i_к\cdot10^3_{(эксп.)}$ (А/см^2)	Плотность катодного тока расчет(1), $i_к\cdot10^3_{(расч.)}$ (А/см^2)	Плотность катодного тока расчет(2), $i_к\cdot10^3_{(расч.)}$ (А/см^2)
2,0	0,1	0,402	3,412	4,398	3,387
	0,2	0,403	4,231	5,366	4,238
	0,5	0,405	5,119	6,798	5,123
	1,0	0,406	6,245	8,445	6,002
3,0	0,1	0,419	3,907	5,456	3,693
	0,2	0,420	4,805	6,765	4,771
	0,5	0,423	5,940	6,377	5,786
	1,0	0,423	7,312	8,389	7,401
5,0	0,1	0,433	5,716	8,003	5,622
	0,2	0,443	7,031	10,014	7,432
	0,5	0,435	8,346	12,352	8,523
	1,0	0,437	9,448	15,284	9,128
6,0	0,1	0,459	5,715	8,040	5,576
	0,2	0,460	7,026	10,004	7,384
	0,5	0,462	8,342	12,221	8,126
	1,0	0,463	9,450	15,291	9,258
7,0	0,1	0,478	5,716	8,003	5,621
	0,2	0,479	7,033	10,017	7,467
	0,5	0,480	8,347	12,356	8,414
	1,0	0,482	9,447	15,178	6,593

Известно, что W(VI) в концентрированных сернокислых растворах ДМСО также восстанавливается на РКЭ, образуя пик тока при E_P = –0,73 В [10], отличающегося от потенциала электровосстанлвления Re(VII) на ~300 мВ, что создает благоприятные условия для четкого разделения аналитических сигналов рения и вольфрама.

Как отмечалось выше, рений входит в состав жаростойких износоустойчивых металлических материалов, к которым относятся сплавы «вольфрамрений» с содержанием Re от 20 до 50% и W от 50 до 80%. На основании полученных данных разработана методика вольтамперо-метрического определения рения в указанных металлических материалах, в т.ч. методика одновременного определения содержания рения и вольфрама. Выполнение определения сводится к следующему: навеску сплава массой ~50 мг растворяют в 10 мл 5 М серной кислоты с добавлением небольшого количества азотной кислоты (пл.1,40 г/см^3) при нагревании. По окончании растворения навески прибавляют 10 мл серной кислоты (пл.1,84 г/см^3) и нагревают до появления паров серной кислоты. Раствор охлаждают, количественно переносят в мерную колбу емк.50 см^3 и доводят объем до метки серной кислотой (пл.1,84 г/см^3). Для определения рения(VII) и вольфрама(VI) аликвотную часть полученного раствора объёмом 10 мл помещают в мерную колбу емк. 25 см^3, содержащую 15 мл диметилсульфоксида, охлаждают, доводят объем до метки серной кислотой пл. 1,84 г/см^3 и тщательно перемешивают. Аликвоту рабочего раствора объемом 10 мл помещают в электролизер и снимают вольтамперограмму в области потенциалов от –0,2 В до –0,8 В, фиксируя катодный пик рения(VII) при –0,43 В и вольфрама(VI) при –0,73 В. Расчет содержания деполяризаторов проводят по градуировочному графику, построенному в координатах «ток–концентрация металла» на фоне сернокислого диметилсульфоксидсодержащего электролита при соотношении компонентов, соответствующем анализируемому раствору. В таблице 2 приведены результаты одновременного вольтамперометрического определения содержания рения и вольфрама в сплаве «ВР».

Таблица 2

Результаты одновременного вольтамперометрического определения рения и вольфрама в сплаве «ВР» на фоне сернокислого ДМСО-содержащего электролита

№ опыта	$C_{Re,}$ %		Погрешность	C_W, %		Погрешность
	по паспорту	найдено		по паспорту	найдено	
1	27,00	27,02	1,2%	72,00	71,96	1,4%
2	27,00	27,01	1,2%	72,00	71,98	1,3%
3	27,00	27,03	1,3%	72,00	72,,02	1,3%
4	27,00	27,00	1,2%	72,00	71,98	1,3%
5	27,00	27,02	1,3%	72,00	72,01	1,2%

Выводы

Изучено вольтамперометрическое поведение рения(VII) в концентрированных (5–7 моль/л) растворах диметилсульфоксида с серной кислотой. Установлено, что рений(VII) в данных условиях необратимо восстанавливается на РКЭ с участием трех электронов, образуя пик тока в области потенциалов от –0,40 до –0,48 В. Найдено, что максимальный ток рения(VII) носит диффузионно-кинетический характер и линейно зависит от его концентрации в растворе при $1{,}5\cdot10^{-5} < C_{Re(VII)} < 2{,}0\cdot10^{-3}$ моль/л, при этом ионы целого ряда элементов не оказывают влияния на его величину. Разработана методика вольтамперометрического определения рения и вольфрама в жаропрочных сплавах «рений-вольфрам», отличающаяся чувствительностью, точностью и простотой аналитической процедуры.

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ECONOMIC SCIENCES

GREEN OFFICE PRINCIPLES IN STRATEGIC MANAGEMENT OF INTERNATIONAL COMPANIES

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Abstract
This article investigates Green Office principles as a core component of strategic management for international companies within the framework of sustainable development and ESG (Environmental, Social, and Governance) strategies. The study defines the conceptual evolution of the Green Office, positioning it as an operational mechanism for implementing corporate environmental and social goals. By systematizing key principles—including energy efficiency, environmental responsibility, digitalization, organizational sustainability culture, and continuous monitoring—the research identifies their function within modern corporate governance systems. Based on an analysis of contemporary literature and global corporate practices, the paper demonstrates that Green Office implementation creates synergy between economic, social, and environmental outcomes. This approach is shown to contribute to reduced operational costs, enhanced labor productivity, a strengthened employer brand, and improved investment attractiveness. Furthermore, the integration of Green Office practices with international standards (ISO 14001, GRI, EMAS) and EU regulatory frameworks (Corporate Sustainability Reporting Directive [CSRD]) is examined, highlighting their growing strategic importance. The study concludes that the Green Office should be viewed not as a standalone environmental initiative, but as a strategic ESG management tool essential for the long-term competitiveness and sustainability of multinational corporations.
Keywords: Green Office, corporate greening, energy efficiency, ESG strategy, digitalization, corporate governance, sustainable development.

Introduction. Amid globalization and growing environmental challenges, sustainable development has become a key priority for international companies. Growing anthropogenic impact on the environment and resource scarcity have intensified external pressures for corporate sustainability. As a result, organizations are increasingly integrating sustainability principles into their strategic management processes. In this context, environmental responsibility extends beyond social initiatives, becoming an integral factor in the long-term competitiveness of firms.

The Green Office concept serves as a practical mechanism for operationalizing sustainable development. It promotes rational use of resources, reduces negative impacts on the environment, and fosters an organizational eco-culture, thereby enhancing management effectiveness. In strategic terms, this approach is recognized not only as an element of operational activities, but also as a component of corporate ESG strategy within international companies, contributing to the minimization of environmental risks, optimization of cost structures, and the strengthening of reputational capital.

The purpose of this article is to provide a theoretical basis for the Green Office concept and to examine its strategic significance in the framework of corporate ESG management. Despite the growing recognition of environmental sustainability in governance structures, the theoretical foundations and strategic approaches linking the adoption of Green Office practices to competitive advantage remain underexplored. The study aims to address this gap by (1) defining the essence and tracing the conceptual evolution of the Green Office; (2) identifying and systematizing the main principles of its adoption; (3) analyzing its role in the strategic management of international companies; and (4) evaluating the strategic advantages and potential challenges of implementing these initiatives.

Literature review. Recent scholarship (2020-2025) examines the Green Office concept through three interrelated lenses:

1. The Green Office as Part of ESG Strategy and a Source of Competitive Advantage for International Companies. At the intersection of globally operating corporations and green transformation, researchers focus on how the international scope of companies and their environmental innovations influence value creation and competitive positioning. Specifically, I. Kim (2021) analyzes the relationship between the degree of internationalization and the perceived value of green innovation, emphasizing that environmental strategies must be aligned with global market demands and institutional frameworks. Within this context, the Green Office represents the operational dimension of environmental strategy realized through internal mechanisms—such as conserving resources, sustainable procurement, waste management, and digitalization—that support broader strategic objectives. Studies published in 2025 demonstrate a positive relationship between ESG strategies and the performance of international companies, highlighting the role of internal organizational mechanisms, including corporate culture and employee engagement practices, in achieving measurable outcomes. Thus, the Green Office functions as both an environmental initiative and a practical mechanism for integrating ESG principles into daily business operations.

2. The Human Factor and Pro-Environmental Behavior in the Workplace. Recent literature indicates

a paradigm shift from an infrastructure-centric understanding of the Green Office toward behavioral drivers. For instance, D. Bangwal (2025) demonstrates how Green Human Resource Management (GHRM) practices mediate employee pro-environmental actions, with training, motivation, and incentive systems emerging as critical success factors for sustainability initiatives. The empirical foundation is supported by Y. Li (2025) research based on 2024 data, which shows that GHRM practices are statistically correlated with sustainable workplace behavior across various sectors. These results suggest that successful Green Office operationalization requires management design through targeted HR instruments.

Alongside these empirical developments, the emergence of bibliometric summaries of studies on workplace green behavior—particularly the work of R. D. Wibisono and S. Salim (2025)—reflects the growing scientific interest in the topic and the strengthening of its theoretical basis. The 2024-2025 research body reveals a significant increase in studies exploring how organizational support, workplace norms, and environmental knowledge influence sustainability practices among staff, with energy and resource conservation as a key focus. Collectively, these findings reinforce the thesis that the Green Office concept has a highly limited effect without comprehensive GHRM approaches, including training programs, internal communication, motivational mechanisms, and leadership that fosters green transformation.

3. Institutional Requirements and Standardization (Reporting and Management Systems). Throughout the 2020-2025 period, scientific discussion has been increasingly structured around the "rules of the game" for sustainable management and reporting. The updated GRI Universal Standards (2021), which became mandatory for reporting as of January 1, 2023, provide an important methodological framework, emphasizing the logic of managing material impacts and transparency.

For companies operating within the European market, this systematic approach is mandated by CSRD; according to the European Commission, these requirements were first applied to the 2024 financial year, with reports to be published in 2025.

Within this regulatory environment, the Green Office is regarded as a formally managed operational unit with key performance indicators (KPIs), control procedures, and reporting data. Academic literature and official sources document the strengthening of the regulatory framework (CSRD) and reporting standardization (GRI), both of which elevate the importance of formalized procedures, quantitative metrics, and performance monitoring. The Green Office thus serves as a practical unit for measurement, auditing, development of KPIs, and reporting in areas including energy consumption, procurement, and waste management. Furthermore, corporate ESG reports of international companies record cases of transition to paperless processes as elements of eco-friendly workplace initiatives. FPT Japan's ESG Report, for instance, illustrates an example of paperless practice implementation (since 2022) as part of the Green Office model. This confirms the underlying management logic that digitalization in such initiatives is not only viewed as IT modernization, but also as a means of resource conservation and a tool for improving environmental performance.

Thus, during 2020-2025, the topic has been well developed at three levels: (a) the strategic environmental transformation of multinational enterprises (MNEs) (Kim, 2021); (b) Green HRM and behavioral mechanisms (Bangwal, 2025; Li, 2025; Wibisono & Salim, 2025); and (c) standardization and regulatory requirements (GRI, European Commission/CSRD). At the same time, there is a limited number of studies combining these dimensions into a single integrated strategic model "Green Office→ ESG-KPIs → Competitive Advantages" for international companies.

Gaps identified (characteristic of scientific sources from 2020-2025):

— Often, either the construction/infrastructure aspects of the Green Office or the behavioral aspects of staff are examined, however, a unified strategic integration model is studied less frequently.

— There is a lack of comparative research evaluating the effectiveness of Green Office instruments across diverse national and cultural contexts as most research focuses on individual countries or industries.

The methodological basis of this study consists of general scientific and special methods of cognition. These include a systematic approach for the comprehensive analysis of the Green Office as an element of the corporate management system; a strategic approach for assessing its role in shaping long-term strategic benefits; and the ESG approach for integrating environmental, social, and governance aspects into the strategic management of international companies.

Results and Discussion.

Theoretical Foundations of the Green Office Concept. Emerging as a practical tool for reducing the negative environmental impact of office activities, the Green Office concept has evolved from individual initiatives to become a systemic element of corporate sustainable development strategy. Initially, this approach was primarily associated with energy conservation, reduced paper use, and rational waste management. However, its scope has since expanded to include employee behavioral aspects, environmental culture, knowledge management, and the digitalization of office processes (Zhang et al., 2024).

Recent studies emphasize that the Green Office is an organizational model that encourages pro-environmental behavior among employees and shapes the overall sustainability performance of companies, not just an infrastructure solution (Bangwal & Tiwari, 2025; Wibisono & Salim, 2025). In the context of MNEs, such frameworks are increasingly recognized as enhancing competitiveness through cost optimization, productivity growth, and stronger brand reputation (Kim, 2021).

Within the current sustainable development paradigm, the Green Office is treated as the operational level of ESG implementation, combining environmental (E), social (S), and governance (G) components. From an environmental perspective, it contributes to

greenhouse gas emissions mitigation, increasing energy efficiency, and bringing down the resource intensity of office processes. The social dimension is realized through the creation of a safe, comfortable, and motivating work environment, while the governance dimension is evident in establishing environmental responsibility standards, policies, and procedures (Liu, 2025).

International non-financial reporting standards, in particular the GRI Universal Standards, explicitly recommend that companies incorporate green workplace practices as part of their environmental management and ESG reporting (Global Reporting Initiative, 2021**).** Simultaneously, new EU regulatory requirements, namely the CSRD, stress the role of internal organizational mechanisms, including office practices, in ensuring organizational activity transparency and sustainability (European Parliament & Council of the European Union, 2022).

In the corporate governance system, the Green Office principles occupy an intermediate position between strategic ESG policies and daily operational processes. They are integrated into internal regulations, codes of conduct, human resource management, and environmental management policies, in accordance with ISO 14001 standards (Song, 2024).

Research demonstrates that the effectiveness of green workplace models depends largely on management support, institutional structures, and the promotion of Green HRM practices that encourage environmentally responsible behavior among employees (Albrecht et al., 2024; Li et al., 2025). Consequently, the Green Office becomes a tool for operationalizing the principles of corporate governance aimed at creating lasting business value.

One of the key theoretical foundations of this concept is the synergy of environmental, economic, and social effects. Ecological initiatives in the office setting contribute to decreasing operating costs through energy efficiency and process digitalization, positively impacting companies' financial results (Kim, 2021). The social effect is reflected in greater employee satisfaction, engagement, and loyalty, as well as in the formation of an environmentally friendly organizational culture (Zhang et al., 2024; Wibisono & Salim, 2025). Together, these factors generate enduring competitive advantages, especially for MNEs operating in an environment of intensified ESG requirements from investors, regulators, and society.

Functional Components of the Green Office in Strategic Management. Energy efficiency is a fundamental element of the Green Office concept and plays a vital role in strategic enterprise management. Applying this principle involves the optimal consumption of electricity, water, heating, and office supplies, along with introducing energy-saving technologies and smart building management systems. From a strategic management viewpoint, energy efficiency not only reduces operating costs, but also bolsters a company's long-term economic sustainability.

Studies show that systematically implementing energy-efficient office solutions can have a significant positive effect on financial performance and labor productivity, particularly within transnational corporations (Kim, 2021; Zhang et al., 2024). In this regard, such measures function as a strategic lever for managing costs and competitiveness.

Environmental responsibility entails conscious management of workplace activities to minimize their ecological footprint. Such measures range from cutting CO_2 emissions and optimizing waste management to using eco-friendly materials and adopting integrated sustainability management systems.

Strategically, commitment to sustainable practices is integrated into the corporate ESG model, forming its non-financial value. Empirical studies indicate that ISO 14001 certification and implementing green initiatives lead to stronger business performance and improved environmental outcomes (Song, 2024). This is highly relevant for companies subject to complex regulatory landscapes and investor expectations regarding ESG compliance.

Digitizing office processes and reducing paper flow are key modern features of the Green Office. This encompasses electronic document management, cloud-based services, remote communication, and business process automation.

In terms of business value, the digitalized Green Office synergizes environmental and economic effects by combining lower resource consumption with prompt management decision-making. Current research suggests that digital office solutions are an integral component of ESG strategy, contributing to mitigating the environmental footprint of companies (Liu, 2025). Ultimately, such digital transformation enhances a company's adaptability and resilience to external challenges.

The essence of sustainability-oriented culture lies in actively engaging workers in the development of green initiatives and fostering pro-environmental behavior throughout the organization. This involves training, motivational programs, visionary leadership, and the embedding of green values into the corporate culture.

Scientific research confirms that Green HRM practices and organizational encouragement significantly amplify employee-level engagement with sustainability practices, thereby maximizing the operational effectiveness of the Green Office (Bangwal & Tiwari, 2025; Li et al., 2025). By integrating these approaches, companies can transform human capital into a source of sustainable competitive advantage (Albrecht et al., 2024).

The final principle of the Green Office as an element of strategic management is continuous monitoring and performance control. Systematic measurement of environmental indicators, analysis of goal achievement, internal auditing, and incorporating the results into the management reporting system facilitate the realization of strategic objectives.

Sustainability oversight, within the ESG management framework, ensures transparency, accountability, and compliance with international non-financial reporting standards. Specifically, GRI standards mandate regular disclosure of information on resource consump-

tion, emissions, and ecological risks, thereby reinforcing the strategic purpose of monitoring (Global Reporting Initiative, 2021). Combined with CSRD requirements, these metrics constitute the foundation for informed management decision-making and increased stakeholder confidence (European Parliament & Council of the European Union, 2022).

The Integration of Green Office Principles into the Strategic Processes of International Companies. Modern MNEs are progressively incorporating eco-friendly office practices directly into their corporate strategies and business models as a viable solution for meeting sustainable development goals. Under this framework, the Green Office is an essential component of operational strategy that affects cost structure, business process organization, and human resource management.

Research shows that introducing environmental innovations—extending from office infrastructure to governance frameworks—increases the strategic value of the firm and contributes to the growth of its market value (Kim, 2021). As part of ESG strategy, the Green Office ensures the operational execution of ecological objectives by integrating them into daily workflows and supporting the transformation of business models toward greater sustainability (Liu, 2025).

Environmental initiatives substantially impact the competitiveness of international companies by enhancing a responsible corporate image and building a strong employer brand. Current global labor market conditions are increasingly characterized by growing emphasis on non-financial factors, including organizational values, social responsibility, and environmental care.

Scientific research demonstrates that organizations actively adopting green workplace practices and Green HRM show higher levels of staff engagement, loyalty, and sustainable behavior, thereby improving labor productivity (Bangwal & Tiwari, 2025; Li et al., 2025). Furthermore, a company's environmental orientation renders it more attractive to highly qualified professionals and investors, securing competitive advantages at the international level (Albrecht et al., 2024).

Applying Green Office principles within the risk management systems of MNEs helps mitigate ecological, regulatory, and reputational risks. Rational resource use, emission reduction, and digitization of workflows enable businesses to adapt to stricter regulatory requirements and growing stakeholder demands.

Consequently, as evidenced by empirical studies, organizations with certified sustainable management systems report higher operational efficiency and environmental performance (Song, 2024). In the long term, these practices foster business resilience, reducing vulnerability to resource and regulatory shocks while supporting the strategic flexibility of international companies necessary for global operations.

Effective integration of Green Office principles into the strategic processes of globally operating firms requires alignment with international sustainability benchmarks. ISO 14001, in particular, outlines the structural requirements for management systems, where green office practices function as instruments for achieving sustainability milestones and fostering continuous improvement (Song, 2024).

The Eco-Management and Audit Scheme (EMAS) complements ISO 14001 by stressing transparency, environmental auditing, and staff involvement, thereby solidifying the Green Office as an element of internal control. In parallel, GRI standards provide a methodological framework for non-financial reporting and enable companies to consolidate the results of green initiatives within their ESG reports (Global Reporting Initiative, 2021). Adhering to these standards improves data comparability, investor confidence, and regulatory compliance, particularly with the EU's CSRD (European Parliament & Council of the European Union, 2022).

Strategic Outcomes and Value Creation of the Green Office for International Companies. A primary strategic advantage of establishing Green Office principles is the tangible economic benefits they yield. Responsible consumption of energy and material resources, together with the digital transformation of office processes and workplace optimization, allows companies to substantially decrease operational expenditures. Amid rising energy costs and tightening environmental regulations, these approaches are essential for maintaining the economic stability of businesses. In this paradigm, the office is no longer a "cost center" but rather a strategic asset that supports the optimization of business processes. A sustainable workplace ecosystem not only facilitates the growth of enterprise market value but also drives high employee productivity, contributing to a competitive position in the global market.

Social effects are another important dimension of the Green Office value proposition, as they directly impact the human capital of MNEs. A comfortable, safe, and ecologically conscious workspace demonstrably improves employee satisfaction, motivation, and commitment to organizational goals.

Studies further indicate a link between the introduction of Green HRM practices and the development of pro-environmental behavior among staff, which ultimately leads to a stronger corporate identity (Bangwal & Tiwari, 2025; Li et al., 2025). From a strategic standpoint, this allows enterprises to minimize staff turnover, increase the attractiveness of the employer brand, and strengthen the internal social stability of the organization (Albrecht et al., 2024).

The ecological effects of the Green Office implementation are the principal outcome, correlating with a reduction in the environmental footprint of corporate activities. This includes energy and water consumption decrease, a transition to paperless operations, waste recycling, and control of greenhouse gas emissions.

Research shows that companies establishing environmental management systems (EMS) and green workplace practices tend to produce optimal ecological results while aligning with international sustainability standards (Song, 2024). Interconnected with digitalization, the Green Office is a robust mechanism for operationalizing the environmental component of an ESG strategy (Liu, 2025).

Table 1.

Strategic Advantages of the Green Office Implementation in MNEs

Area of Strategic Impact	Key Manifestations of the Green Office	Strategic advantages for MNEs	ESG Dimension
Economic Efficiency	• Energy-optimized workplaces • Rational use of resources • Digitalization of office processes	• Reduction of operating costs • Higher labor productivity • Process efficiency maximization	**E:** lower resource consumption rates **G:** effective cost management
Human Capital Management	• Green HRM • A comfortable and secure working environment • Employee engagement in green initiatives	• Greater staff motivation and enthusiasm • Minimized staff turnover • Improved work performance	**S:** Personnel well-being and engagement
Corporate Culture and Values	• Building an environmental organizational culture • Sustainability leadership • Staff eco-friendly behavior	• Employee identification with corporate strategy • Stronger collective identity	**S:** social responsibility **G:** ethical management
Environmental Performance	• CO_2 mitigation • Reduced material waste • Paperless office	• Environmental risk management • Compliance with international standards	**E:** improvement of sustainability metrics
Risk Management and Resilience	• Environmental management systems • Monitoring and controlling • Adherence to ISO and GRI standards	• Minimized regulatory and reputational risks • Progress toward long-term business sustainability	**G:** organizational risk control **E:** meeting environmental standards
Reputation and Employer Brand	• Green corporate image • ESG communication • Transparent non-financial reporting	• More attractive employer value proposition • Talent acquisition and recruitment • Stakeholder trust and credibility	**S:** organizational employee appeal **G:** transparency
Investment Attractiveness	• High ESG ratings • CSRD and GRI compliance • ESG reporting	• Facilitated access to sustainable financing • Lower cost of capital	**G:** investment transparency **E/S:** ESG compliance

Note: E—Environmental; S—Social; G—Governance. **Source:** Compiled from recent studies of the Green Office, Green HRM, and ESG strategies of international companies (Kim, 2021; Bangwal & Tiwari, 2025; Li et al., 2025; Song, 2024; Global Reporting Initiative, 2021).

Thus, the institutionalization of Green Office principles provides multinational enterprises with significant reputational and investment advantages. In the current global business landscape, environmental responsibility and corporate accountability have become important criteria for investors, employees, and consumers in their evaluation of organizations. Systematic workplace sustainability practices help increase stakeholder trust in the company while improving its ESG profile.

Adherence to international non-financial reporting standards, particularly the GRI framework, as well as EU CSRD, facilitates access to green financing and lowers the cost of capital (Global Reporting Initiative, 2021; European Parliament & Council of the European Union, 2022). Ultimately, by adopting the Green Office approach, multinational companies create value across multiple dimensions, attracting investors, enhancing enterprise reputation, and building enduring competitiveness.

Examples of the Green Office Implementation in International Companies. Google is one of the global leaders in applying Green Office principles, which are integrated into its corporate ESG strategy and innovative development model. The organization's facilities operate on 100% renewable energy and extensively use smart energy management systems, intelligent lighting, and digital platforms to minimize resource waste.

From a strategic management perspective, Google's Green Office serves a dual purpose: it aids in reducing operating costs and the carbon footprint while

fostering employee productivity and creativity. Research indicates that such pro-environmental innovations are associated with increased market valuation and international competitiveness of multinational enterprises (Kim, 2021; Liu, 2025).

Microsoft views the Green Office as a robust instrument for managing climate and regulatory risks. The company has incorporated energy efficiency, digitalization, and paperless document management principles into all office processes, combining them with its overall objective of achieving carbon negativity.

Through this approach, Microsoft succeeds in mitigating environmental risks, complying with international ESG reporting standards, and enhancing investor confidence. Moreover, the Green Office supports alignment with ISO 14001 and GRI requirements, thereby reinforcing the systematic nature of sustainable management (Song, 2024; Global Reporting Initiative, 2021).

Unilever exemplifies an organization where green office practices are closely integrated with both the corporate culture and human resource management. As part of the Unilever Sustainable Living Plan, these practices are introduced alongside Green HRM programs aimed at cultivating pro-environmental attitudes among employees.

Empirical studies demonstrate that such integration of environmental initiatives into HR policy is critical for staff motivation, engagement, and commitment, which represent valuable strategic assets for international companies (Bangwal & Tiwari, 2025; Li et al., 2025). Thus, Unilever's Green Office strategy contributes to employer brand credibility and the social component of the ESG framework.

IKEA actively incorporates pro-environmental workplace principles within its sustainable development business model focused on the circular economy. The company's office spaces are characterized by high energy efficiency, the use of environmentally friendly materials, digitalized document flow, and staff involvement in sustainable programs. IKEA's strategic management aims for an optimal balance between economic, ecological, and social effects, positioning the Green Office as an element of its global reputation strategy.

Table 2.

The Green Office Principles in the Strategic Management of MNEs

Company	The Green Office Principles	Strategic Objectives	ESG Effect
Google	• 100% renewable energy in offices • Smart energy management systems • Digitalized workflows • Comfortable workplaces	• Reduced operating costs • Greater productivity and innovation • Attracting global talent	**E:** CO_2 mitigation **S:** employee well-being and engagement **G:** ESG corporate strategy
Microsoft	• Energy-efficient office buildings • Paperless office • Internal environmental monitoring • ISO 14001 certification	• Climate and regulatory risk management • Long-term business resilience	**E:** minimized environmental footprint **S:** improved digital workplace **G:** ESG accountability and transparency
Unilever	• Green HRM • Employee engagement in sustainability programs • Energy- and resource-efficient offices	• Ecological corporate culture • Building a credible employer brand	**E:** rational consumption of resources **S:** higher personnel motivation and loyalty **G:** ESG goal alignment
IKEA	• Low-energy office facilities • Use of environmentally friendly materials • Circular economy principles • Digitalized document management	• Synergy between economic, social, environmental goals • Increased reputation and investment attractiveness	**E:** lower levels of waste and emissions **S:** responsible workplace **G:** integration of sustainability into business model

Note: E—Environmental; S—Social; G—Governance. **Source:** Compiled from recent research on the Green Office, Green HRM, ESG integration, and sustainable strategic management in international companies (Kim, 2021; Bangwal & Tiwari, 2025; Li et al., 2025; Song, 2024; Global Reporting Initiative, 2021).

The experience of leading MNEs showcases that the Green Office:

— integrates into corporate strategy and business model;

— supports risk management and enduring business performance;

— improves employer reputation and staff involvement;

— creates economic and reputational advantages.

Hence, the potential of these sustainability initiatives lies in providing strategic benefits across multiple aspects of organizational performance.

Barriers and Challenges to Green Office Development. One key barrier to the effective integration of the sustainable workplace model involves organizational and managerial constraints related to the lack of clear strategic prioritization of environmental approaches. In many international companies, the Green Office is perceived as a peripheral or image-oriented project. Consequently, it often lacks commitment from top management and remains disconnected from central strategic planning.

Research highlights insufficient coordination between functional departments, weak corporate governance, and the absence of KPIs for environmental performance as factors that significantly undermine the success of the sustainable office model (Albrecht et al., 2024; Wibisono & Salim, 2025). Under these conditions, the Green Office fails to achieve synergy with business objectives, thereby losing its strategic relevance.

Financial and infrastructural barriers pose substantial challenges to adopting Green Office principles, particularly for MNEs with extensive global facilities. Since the initial capital expenditures required for energy-efficient technologies, building modernization, digital management systems, and certification are relatively high, the introduction of these measures is frequently hindered by short-term financial considerations.

At the same time, research indicates that a deficiency in strategic vision and financial planning often leads to an underestimation of the potential economic benefits of sustainable workplace models (Kim, 2021). In addition, outdated infrastructure and limited access to modern technologies in various countries where companies operate complicate the standardization of Green Office practices (Song, 2024).

Cultural and behavioral factors constitute less obvious yet equally significant obstacles. Employee resistance to change, low levels of environmental awareness and internal motivation can undermine the efficacy of even well-designed green initiatives.

In turn, pro-environmental staff attitudes depend largely on organizational culture, leadership style, and incentive systems (Bangwal & Tiwari, 2025; Li et al., 2025). Within international companies, cultural heterogeneity presents an additional challenge, which complicates the implementation of sustainable practices and necessitates adaptive, culturally sensitive management frameworks (Wibisono & Salim, 2025).

Overcoming the previously discussed barriers requires the institutionalization of the Green Office concept in the strategic management systems of MNEs. This primarily entails active executive sponsorship, a clear definition of environmental goals, and the inclusion of sustainability indicators within the corporate KPIs system.

Scientific literature emphasizes the role of a dual-incentive structure—combining financial and non-financial rewards—alongside the development of Green HRM. Employee training programs and shaping environmental leadership help to tackle behavioral barriers (Albrecht et al., 2024; Bangwal & Tiwari, 2025). Moreover, adherence to international standards (ISO 14001, GRI) and ESG reporting requirements enhances the systematization of green initiatives, improving their transparency and measurability (Global Reporting Initiative, 2021).

Therefore, taking a comprehensive approach to addressing organizational, financial, and cultural barriers enables companies to reposition the Green Office—moving it from a perceived "cost center" to a driver of long-term resilience and competitive advantage.

Conclusion. The present paper demonstrates that in the contemporary organizational landscape the Green Office concept has evolved from a localized environmental project into a systemic component of strategic management for international companies. By functioning as a practical tool for advancing ESG strategy at the operational level, the Green Office integrates environmental, social, and governance objectives into routine business workflows. Findings of this study establish that introducing this concept contributes to the following strategic advantages: economic (through cost optimization and increased operational efficiency), social (via greater employee motivation and engagement, fostering sustainable organizational culture), ecological (through emissions and waste reduction), and reputational (strengthening of the ESG profile and investment appeal). This study highlights the importance of the synergy between the Green Office and Green HRM, given its overall impact on pro-environmental behavior of staff and the long-term efficacy of sustainability initiatives. Concurrently, a set of barriers to the implementation of green principles has been identified, stemming from organizational constraints, financial costs, and complex cultural and behavioral factors. Successful navigation of such barriers requires strategic support from senior management, integration of environmental performance KPIs, and aligning Green Office practices with international reporting standards.

While these findings highlight numerous positive implications of the sustainable workplace model, they also indicate several gaps to be addressed by further research. First, there is a need for empirical study of specific Green Office instruments and their direct impact on both economic and broader indicators using quantitative analysis methods. Second, comparative analysis across diverse industries and geographic regions could inform how institutional and cultural differences influence environmental outcomes. Third, developing integrated models that link strategic, operational, and behavioral management levels, specifically exploring the relationship between the Green Office, ESG-KPIs, and value creation, could provide a more comprehensive theoretical framework. Fourth, it is essential to examine the role of digital technologies—such as paperless office systems, smart building infrastructure, and ESG analytics platforms—in enhancing green office performance in the context of global business digitalization. Finally, further investigation of Green HRM practices, as a critical determinant of long-term success of sustainability initiatives in MNEs, could deepen understanding of human and organizational factors underlying effective environmental management.

Pursuing research in these directions would advance scientific understanding and practical application

of the Green Office concept, contributing to the development of actionable evidence-based recommendations for international companies.

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DIGITAL LEADERSHIP AND ORGANIZATIONAL PERFORMANCE: THE MEDIATING ROLE OF DIGITAL TRANSFORMATION

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Abstract

As organizations increasingly adopt digital technologies, leadership has emerged as a critical factor influencing the outcomes of digital initiatives. While prior studies have examined the direct relationship between leadership and organizational performance, less attention has been paid to the mechanisms through which digital leadership contributes to performance outcomes. This study investigates the mediating role of digital transformation in the relationship between digital leadership and organizational performance. Drawing on upper echelons theory and dynamic capability theory, the paper argues that digital leadership shapes strategic priorities, resource allocation, and organizational learning, which in turn enable effective digital transformation. By synthesizing evidence from prior empirical research and organizational practices, the study demonstrates that digital leadership enhances organizational performance primarily by facilitating meaningful digital transformation rather than through direct influence alone. The findings offer practical insights for managers and contribute to the DBA literature by clarifying how leadership-driven digital initiatives translate into performance gains.

Keywords: Digital Leadership; Digital Transformation; Organizational Performance; Upper Echelons Theory; Dynamic Capabilities.

1. Introduction

Digital technologies have become deeply embedded in organizational operations, reshaping how firms compete, coordinate, and create value. However, organizations adopting similar digital tools often experience markedly different performance outcomes. This divergence suggests that technology alone does not determine success; instead, leadership plays a decisive role in shaping how digital initiatives are conceived, implemented, and sustained.

Digital leadership refers to leaders' ability to understand digital technologies, articulate a digital vision, and mobilize organizational resources toward digital transformation (Kane et al., 2019). In practice, digital leadership extends beyond technical expertise and encompasses strategic judgment, cultural influence, and change management capabilities. From a DBA perspective, understanding the role of digital leadership is essential because senior managers and executives are often the primary drivers of digital initiatives.

This paper examines the relationship between digital leadership and organizational performance, with a particular focus on the mediating role of digital transformation. Rather than assuming a direct effect, the study argues that digital leadership improves performance by enabling and shaping digital transformation processes. By integrating leadership and digital transformation literatures, this study seeks to clarify the mechanisms through which leadership-driven digital initiatives contribute to organizational performance.

2. Literature Review

2.1 Digital Leadership

The concept of digital leadership has gained prominence alongside the rise of digital transformation. Unlike traditional leadership styles, digital leadership emphasizes technological awareness, adaptability, and the ability to manage uncertainty in rapidly changing environments (Avolio et al., 2014). Digital leaders are not necessarily technical experts; rather, they possess sufficient digital literacy to make informed strategic decisions and guide organizational change.

Empirical studies suggest that digital leadership influences employees' attitudes toward technology adoption and fosters a culture of experimentation and learning (Kane et al., 2019). Leaders who actively support digital initiatives signal their strategic importance, thereby reducing resistance and encouraging organizational engagement. This aligns with upper echelons theory, which posits that organizational outcomes reflect the values and cognitive frames of top executives (Hambrick & Mason, 1984).

2.2 Organizational Performance

Organizational performance is a multidimensional construct encompassing financial outcomes, operational efficiency, innovation capability, and market competitiveness. Management scholars increasingly

recognize that performance outcomes are shaped not only by external market conditions but also by internal leadership and capability configurations (Richard et al., 2009).

In the context of digitalization, performance improvements are often linked to enhanced agility, improved decision-making, and more efficient resource utilization. However, these outcomes are rarely immediate, as digital initiatives typically require significant organizational learning and process redesign.

2.3 Digital Transformation as a Mediating Mechanism

Digital transformation refers to the integration of digital technologies into organizational strategies, processes, and structures, leading to fundamental changes in how organizations operate (Vial, 2019). Research suggests that digital transformation mediates the relationship between leadership and performance by translating strategic intent into operational change.

Dynamic capability theory provides a useful lens for understanding this process. According to Teece (2018), leaders play a critical role in sensing opportunities, seizing digital resources, and reconfiguring organizational capabilities. Without effective leadership, digital technologies may remain underutilized, limiting their performance impact.

3. Theoretical Framework and Hypothesis Development

This study integrates upper echelons theory and dynamic capability theory to explain the mediating role of digital transformation. Upper echelons theory emphasizes how leaders' cognition and values shape strategic choices, while dynamic capability theory explains how organizations adapt and renew capabilities in changing environments.

Digital leaders influence organizational performance by prioritizing digital initiatives, allocating resources, and fostering learning-oriented cultures. These actions enable digital transformation, which subsequently enhances organizational performance. Figure 1 illustrates the conceptual framework.

Based on this reasoning, the following hypotheses are proposed:

H1: Digital leadership has a positive effect on digital transformation.

H2: Digital transformation has a positive effect on organizational performance.

H3: Digital transformation mediates the relationship between digital leadership and organizational performance.

4. Mechanisms Linking Digital Leadership and Performance

Digital leadership affects organizational performance through several interrelated mechanisms.

First, digital leaders shape strategic direction by articulating a clear digital vision. This vision aligns digital initiatives with organizational goals, reducing ambiguity and improving coordination (Kane et al., 2019).

Second, digital leaders support capability development by investing in employee training and encouraging cross-functional collaboration. Such investments strengthen the organization's ability to implement digital solutions effectively.

Third, digital leaders foster a culture of experimentation and learning. By tolerating calculated risks and learning from failures, leaders enable continuous improvement and innovation, which are essential for successful digital transformation (Teece, 2018).

Table 1 summarizes these mechanisms and their implications.

Table 1.

Digital Leadership Mechanisms and Organizational Outcomes

Digital Leadership Dimension	Managerial Actions	Expected Organizational Outcomes
Digital Vision	Communicating strategic digital goals	Strategic alignment and clarity
Capability Development	Training and cross-functional teams	Effective digital transformation
Learning-Oriented Culture	Encouraging experimentation	Innovation and adaptability

5. Discussion

The analysis suggests that digital leadership influences organizational performance primarily through its impact on digital transformation. This finding has important implications for both theory and practice. From a theoretical perspective, it highlights the importance of examining mediating mechanisms rather than assuming direct leadership effects. From a practical standpoint, it suggests that managers should focus less on symbolic digital initiatives and more on building organizational capabilities that support transformation.

For DBA practitioners, the study underscores the role of leadership as an enabler rather than a substitute for digital transformation. Leaders cannot directly "command" performance improvements; instead, they must create conditions that allow digital initiatives to reshape organizational processes and behaviors.

6. Conclusion

This study examined the relationship between digital leadership and organizational performance, emphasizing the mediating role of digital transformation. Drawing on upper echelons theory and dynamic capability theory, the paper argued that digital leadership enhances performance by enabling effective digital transformation rather than through direct influence alone. The findings contribute to the DBA literature by offering a nuanced understanding of how leadership-driven digital initiatives translate into organizational outcomes.

Future research may empirically test the proposed framework using survey data or case studies to further validate the mediating role of digital transformation across different organizational contexts.

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INSTITUTIONAL AND CULTURAL FOUNDATIONS OF CHINA'S ECONOMIC GROWTH

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Abstract

The rapid and sustained economic growth of the People's Republic of China represents one of the most significant phenomena in the contemporary global economy. This study aims to provide a comprehensive explanation of China's distinctive development model, which diverges from classical liberal economic theories and the conventional framework of the Washington Consensus. The research examines China's economic rise through the interaction between institutional mechanisms and deeply embedded cultural paradigms. The methodological framework combines institutional economics, historical-comparative analysis, and cultural interpretation. The findings demonstrate that China's economic success is rooted in the integration of the developmental state model with adaptive property-rights arrangements, fiscal decentralization, and Confucian ethical principles promoting meritocracy, discipline, and educational commitment. The interaction between institutional flexibility and cultural continuity has enabled China to achieve sustained competitiveness in global markets while preserving economic sovereignty.

Keywords: China's economy; Confucian ethics; institutional transformation; developmental state; property rights; economic growth model.

Introduction

The policy of "reform and opening-up" (Gaige Kaifang), initiated in the People's Republic of China in 1978, laid the foundation for one of the most profound economic transformations in modern economic history. Within just a few decades, China evolved from a predominantly agrarian economy into the world's second-largest economic power, demonstrating that sustained economic development is possible outside the classical framework of the Washington Consensus. The distinctiveness of the Chinese model lies in its ability to integrate market-oriented instruments with centralized state planning and deeply rooted historical and cultural traditions.

When analyzing the driving forces behind China's economic growth, it is insufficient to focus solely on quantitative factors such as capital inflows, technological progress, or low labor costs. Modern institutional economics emphasizes that long-term growth depends not only on factor accumulation but also on the quality of institutions that shape incentives and coordinate economic activity (North, 1990; Acemoglu & Robinson, 2012). In this regard, China presents a unique case: instead of adopting rapid liberalization and privatization, it implemented gradual, experimental reforms embedded in existing governance structures.

At the core of the Chinese economic transformation are institutional dynamics, including the evolution of property rights, gradual decentralization reforms, and a meritocratic system of governance. These institutional changes have been closely intertwined with cultural norms shaped by Confucian values, which emphasize discipline, collective responsibility, hierarchy, and a strong commitment to education. Together, these elements have formed the moral and sociological infrastructure underlying China's economic processes.

For this reason, the analysis of China's economic performance requires a multidimensional approach that accounts for the interaction between the state's role in the market, the pace of institutional change, and society's capacity for cultural adaptation. China's success should not be interpreted as a random breakthrough, but rather as the outcome of institutional innovations tailored to national cultural conditions at a specific historical moment. This article seeks to shed light on the less visible dimensions of China's development model—namely, the institutional architecture and cultural motivations that underpin the country's impressive economic performance beyond aggregate growth statistics.

Institutional Architecture of Economic Development

When examining the institutional foundations of China's economic growth, one of the most striking features is the unique balance between a centralized state apparatus and a significant degree of regional autonomy. Following the reforms initiated in 1978, fiscal decentralization provided local governments with strong incentives to promote economic development. The career advancement of regional officials became directly linked to the GDP growth performance of the territories under their administration, thereby creating an environment of regional economic competition (Lin, 2012).

This performance-based promotion mechanism is often described as a "promotion tournament" within the Chinese administrative hierarchy. Regional leaders were incentivized to attract investment, expand industrial output, and develop infrastructure in order to demonstrate measurable economic success. Such incentive alignment reduced principal–agent problems between central and local authorities and contributed to dynamic regional competition.

Within this framework, the Chinese Communist Party introduced a meritocratic selection mechanism that ensured that the most successful administrators were promoted to higher levels of governance. This institutional arrangement corresponds to the theoretical model of the "developmental state," in which bureaucratic capacity and long-term strategic planning guide industrial transformation (Rodrik, 2000).

China's trajectory in the area of property rights has also followed a highly distinctive path. While Western

economic theories often claim that secure private property rights constitute a prerequisite for sustained growth, China managed to successfully integrate collective ownership into a market-oriented system through the development of Township and Village Enterprises (TVEs). Although formally owned by the state or local communities, these enterprises operated largely according to market principles (Naughton, 2018). This quasi-private form of ownership accelerated rural industrialization while maintaining social stability during transition.

In addition, the dual-track pricing system allowed state planning and market allocation to function simultaneously. By permitting enterprises to sell surplus output at market prices after fulfilling state quotas, China gradually introduced profit incentives without dismantling the existing system overnight. Such institutional flexibility enabled transformation through evolutionary adaptation rather than through "shock therapy."

The financial system also played a crucial institutional role. State-owned banks directed credit toward priority sectors, infrastructure projects, and industrial expansion. This form of coordinated credit allocation ensured high investment rates and supported large-scale capital formation. Unlike fully liberalized financial systems, China's banking structure remained closely aligned with national development goals, reinforcing the state's strategic capacity.

The establishment of Special Economic Zones (SEZs) further illustrates China's experiment-based reform strategy. Cities such as Shenzhen served as testing grounds where new regulatory practices were implemented before nationwide adoption (Coase & Wang, 2012). This experimentalism minimized systemic risks and allowed policymakers to evaluate policy effectiveness in controlled environments.

Cultural Factors and the Economic Impact of Confucian Ethics

Explaining China's economic growth solely through laws, political decisions, or formal institutional reforms would mean overlooking the deeper internal dynamics of Chinese society. If we extend Max Weber's logic from *The Protestant Ethic and the Spirit of Capitalism* to the East Asian context, it becomes evident that Confucian values have provided China with a comparable moral foundation for economic development.

Confucianism emphasizes loyalty to the family, respect for hierarchy, discipline, and the central importance of education. These principles have strongly influenced the structure of Chinese society and shaped the quality of its labor force. A culturally embedded commitment to education facilitated rapid human capital accumulation, which is widely recognized in growth theory as a key determinant of productivity (Hofstede, 2001).

The cultural norm of meritocracy also complements China's institutional governance model. Historically, civil service examinations rewarded academic achievement and administrative competence. Modern governance mechanisms echo this tradition by emphasizing performance evaluation and educational qualifications in public administration.

A particularly important cultural mechanism is the system of *guanxi*—informal social networks based on trust and reciprocity. In contexts where formal legal systems are evolving, such networks reduce transaction costs and facilitate economic coordination (Landa, 1994). *Guanxi* networks have played a significant role in supporting small and medium-sized enterprises and in mobilizing capital from overseas Chinese communities.

Moreover, the cultural tradition of thrift and high household savings has ensured the availability of substantial domestic investment resources. High savings rates allowed China to finance infrastructure and industrial development without excessive dependence on foreign borrowing. In macroeconomic terms, the savings–investment link became a structural pillar of China's growth model.

Thus, China's experience demonstrates that cultural norms are not passive background variables, but active forces interacting with institutional structures to shape economic development outcomes.

Conclusion

An analysis of the economic rise of the People's Republic of China leads to the conclusion that the country's success cannot be attributed solely to market-oriented mechanisms or centralized state authority. Rather, China's distinctive development trajectory is rooted in the synthesis of these elements through the prism of national cultural traditions.

Institutional flexibility—manifested in adaptive property rights, fiscal decentralization, and experimental reforms—provided resilience and strategic coherence. At the same time, Confucian ethical principles fostered discipline, meritocracy, and human capital formation. Informal social networks reduced transaction costs, while high savings supported capital accumulation.

China's experience demonstrates that economic development trajectories are intrinsically linked to historical memory, cultural values, and institutional legacy. The Chinese model should therefore be understood not as a universal template, but as a context-specific example of how institutional rationality and cultural continuity can be harmonized.

Looking ahead, China faces challenges related to digital transformation, demographic change, environmental sustainability, and global economic competition. The continued success of its development model will depend on its ability to adapt institutional mechanisms while preserving the cultural foundations that have historically supported economic dynamism.

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CRYPTOGRAPHY AS AN INSTITUTIONAL MECHANISM OF TRUST IN THE DIGITAL ECONOMY

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Abstract

The rapid digitalization of economic activities has made trust a critical resource, essential for efficient and secure market interactions. This study examines cryptography as an institutional mechanism of trust, analyzing how cryptographic protocols-including blockchain, smart contracts, encryption, and consensus algorithms-function as substitutes for or complements to traditional institutions such as banks and regulatory authorities. The paper is grounded in the framework of New Institutional Economics and transaction cost theory, and it explores the role of cryptography in reducing information asymmetries, mitigating opportunistic behavior, and enhancing transparency in digital transactions. The empirical analysis compares conventional financial systems with decentralized platforms, demonstrating that cryptographically based mechanisms reduce transaction costs, improve market efficiency, and strengthen institutional trust in environments characterized by weak or ineffective formal institutions. The findings suggest that cryptography is not merely a technical tool for data protection, but represents a new institutional paradigm that redefines trust relations and modes of market governance. The implications extend to regulatory frameworks, public policy design, and the future development of financial institutions in the digital economy.

Keywords: cryptography; institutional trust; digital economy; transaction costs; blockchain; decentralized systems; smart contracts.

Introduction

In the contemporary digital economy, trust represents one of the key prerequisites for the functioning of markets, the stability of economic relations, and the efficient exchange of goods and services. The digitalization of economic processes, the growth of online transactions, and the expansion of global digital platforms have intensified interactions among economic actors who often do not know each other, operate in different institutional and legal environments, and rely on information and communication technologies as the primary channel of exchange. Under such conditions, traditional trust mechanisms based on reputation, personal relationships, and territorially bounded institutional frameworks are becoming increasingly ineffective, raising the question of new ways to establish and maintain trust in the digital space. Traditional economic institutions, such as banks, regulatory bodies, and other intermediaries, have historically played a central role in ensuring trust, enforcing contractual obligations, and reducing risk in economic transactions. However, in the digital environment their effectiveness faces numerous limitations, including high transaction costs, procedural slowness, territorial fragmentation of regulation, and a limited ability to adapt to the speed of technological change. In addition, the centralized nature of these institutions increases system vulnerability to abuse, systemic failures, and the loss of user trust, particularly in the context of a global and decentralized digital economy.Against this background, the main research question of this paper is: in what ways does cryptography function as an institutional mechanism of trust in the digital economy, and to what extent can it replace or complement the role of traditional economic institutions? The objective of the paper is to analyze the role of cryptographic protocols in building trust, with particular emphasis on their ability to reduce information asymmetry, transaction costs, and the need for centralized intermediaries. A specific objective is to examine the economic implications of applying cryptography in digital financial systems and platforms. The scientific contribution of this study lies in conceptualizing cryptography not merely as a technical means of data protection, but as a new institutional form of trust in the digital economy, grounded in mathematically verifiable and decentralized mechanisms. The paper contributes to the existing literature in New Institutional Economics and digital economy studies by linking theoretical approaches with contemporary technological practices. The structure of the paper is organized as follows: after the introduction and theoretical framework, the role of cryptography as an institutional mechanism of trust is analyzed, followed by an examination of empirical aspects and implications for digital market systems, while the final section presents conclusions and recommendations for future research and public policy design.

Theoretical Framework and Literature Review

Trust represents one of the fundamental categories of economic analysis, particularly under conditions of complex market interactions and uncertainty. In economics, trust is most commonly viewed as a mechanism that reduces uncertainty, facilitates exchange, and

encourages cooperation among economic actors in situations where complete contractual protection is not possible. From an institutional perspective, trust is not based solely on individual expectations, but is deeply embedded in formal and informal institutions that regulate economic behavior. Institutions such as legal systems, financial intermediaries, and regulatory bodies have traditionally served as guarantors of trust by ensuring contract enforcement and reducing the risk of opportunistic behavior[1]. New Institutional Economics has further deepened the understanding of trust through the analysis of the role institutions play in shaping economic relations. Within this framework, institutions are defined as the "rules of the game" in society that structure interactions among individuals and organizations[2]. Particularly important in this context is transaction cost theory, according to which the costs of negotiation, monitoring, and contract enforcement represent a key factor in the choice of institutional arrangements. Trust thus emerges as a mechanism for reducing transaction costs, as it diminishes the need for complex contracts and intensive monitoring[3]. However, in the digital economy—where transactions are often anonymized, cross-border, and automated—traditional institutional mechanisms of trust demonstrate limited effectiveness. Contemporary economic literature increasingly examines the role of cryptography as the technological foundation of new institutional arrangements. Through encryption, digital signatures, hash functions, and consensus algorithms, cryptography enables mathematically verifiable security and transaction validation without the need for centralized intermediaries. Research in the field of blockchain economics indicates that cryptographic protocols can assume functions previously performed by formal institutions, particularly in ensuring trust and contract enforcement. In this sense, cryptography is not viewed merely as a technical tool, but as a key component of the institutional infrastructure of digital markets[4]. An increasing body of economic literature focuses on the concept of so-called "cryptographic trust," which is based on algorithmic rules and decentralized consensus rather than institutional authority or the reputation of individual actors. Empirical studies suggest that this form of trust can contribute to reducing information asymmetries, increasing market efficiency, and strengthening system resilience to institutional weaknesses, especially in economies with underdeveloped formal institutions. Nevertheless, most existing studies either concentrate on the technical aspects of cryptography or provide descriptive analyses of crypto-markets, without deeper theoretical integration with institutional economics[5]. Based on the review of the relevant literature, a clear research gap can be identified. Although numerous studies examine the economic effects of digital technologies and blockchain systems, there is a lack of systematic theoretical analysis of cryptography as an institutional mechanism of trust within the framework of New Institutional Economics. In particular, the role of cryptographic protocols in reducing transaction costs and their relationship to traditional institutional arrangements remains insufficiently explored. This paper seeks to address this gap by integrating institutional theory and contemporary cryptographic practices in the analysis of the digital economy.

Cryptography as an Institutional Mechanism

In the contemporary digital economy, cryptographic protocols increasingly assume roles that were traditionally performed by institutions in ensuring trust among market participants. As a substitute for institutional trust, these protocols provide mathematically verifiable transaction security and automated rule enforcement, thereby reducing the need for centralized intermediaries and indirectly enhancing market efficiency[6]. This approach redefines the role of trust in economic relations, as it no longer relies exclusively on institutional reputation or legal oversight, but rather on algorithmically grounded mechanisms that are transparent and immutable. The core elements of cryptographic mechanisms include encryption, digital signatures, and hash functions. Encryption enables confidential transactions by preventing unauthorized access to sensitive information. Digital signatures guarantee the integrity and authenticity of digital messages or contracts, while hash functions ensure data immutability through one-way mathematical transformations[7]. The combination of these tools creates an environment in which participants can trust that transactions are secure and that rules are enforced, even in the absence of a centralized authority. Beyond these foundational cryptographic tools, consensus algorithms and decentralized governance constitute key mechanisms for maintaining trust in distributed systems. Algorithms such as Proof-of-Work (PoW) and Proof-of-Stake (PoS) allow network participants to verify transactions and reach agreement on the system's state without reliance on a central institution[8]. This model of decentralized consensus reduces the risk of manipulation and opportunistic behavior, thereby algorithmically generating trust that is functionally equivalent to institutional trust in traditional systems. The distinction between cryptographic trust and traditional institutional trust lies primarily in the source of legitimacy and the mechanisms of enforcement. Traditional institutions rely on legal

[1] Arrow, K. J. (1972). Gifts and exchanges. Philosophy & Public Affairs, 1(4), 343–362.

[2] North, D. C. (1990). Institutions, Institutional Change and Economic Performance. Cambridge: Cambridge University Press.

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[6] Gans, J. S. (2019). The case for an algorithmic institution: Cryptography as governance. Journal of Institutional Economics, 15(4), 579–596.

[7] Narayanan, A., Bonneau, J., Felten, E., Miller, A., & Goldfeder, S. (2016). Bitcoin and cryptocurrency technologies: A comprehensive introduction. Princeton: Princeton University Press.

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frameworks, reputation, and hierarchical procedures, whereas cryptographic systems operate on the basis of mathematically verifiable rules and automated mechanisms. Although both models aim to reduce uncertainty and opportunism, the cryptographic approach enables broader global applicability, high scalability, and transparency without the need for physical or legal authority[9]. Empirical research indicates that this form of trust increases the efficiency of digital markets and contributes to system stability in environments with limited institutional capacity[10].

Digital Economy and the Transformation of Economic Institutions

Figure No. 1. Digital Economy and the Transformation of Economic Institutions

The digital economy brings significant changes to the structure and functioning of economic institutions, creating new forms of interaction and redefining traditional economic relationships. Digital platforms-such as e-commerce, financial, and data exchange services-enable users and firms to participate in market transactions without direct physical contact and often without intermediaries[11]. These models are based on the network economy and economies of scale, where network value grows exponentially with the number of users, and interactions rely on algorithmically grounded mechanisms of verification and trust. Within this environment, blockchain infrastructure represents a key institutional innovation. Its decentralized and immutable ledger enables transparency and transaction integrity, providing an alternative to traditional institutions that have historically guaranteed trust in economic processes[12]. Blockchain technology functions as a "digital institution," in which consensus algorithms, cryptographic verification, and distributed architecture replace hierarchical and centralized oversight mechanisms. One of the most significant aspects of blockchain infrastructure is smart contracts, which automate the execution of contractual obligations according to predefined rules[13]. Smart contracts embed trust in contractual compliance directly into the technology, reducing the need for intermediaries and legal enforcement mechanisms. These tools increase efficiency, accelerate transactions, and reduce the risk of human error or opportunism, which is particularly important in cross-border and digitally intensive markets. The transformation of intermediaries in the digital economy is bidirectional. On the one hand, centralized intermediaries lose their traditional monopoly over information and trust; on the other hand, new types of intermediaries emerge to enable interoperability, provide technical support, and facilitate regulatory coordination[14]. This shift leads to a redefinition of institutional roles and economic relationships, in which trust is no longer tied exclusively to institutional authority but increasingly to technical reliability, algorithmic verification, and the reputation of digital platforms. Contemporary empirical studies indicate that digital platforms, blockchain, and smart contracts not only increase efficiency and reduce transaction costs but also strengthen institutional trust in systems with underdeveloped formal institutions[15]. These findings confirm that technologically grounded trust mechanisms can partially or fully substitute traditional institutional functions, opening space for new models of organization and regulation of economic activity.

Research Methodology

This study employs a combined research design that integrates qualitative and quantitative approaches

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[10] Li, X., Jiang, P., Chen, T., Luo, X., & Wen, Q. (2021). A survey on the security of blockchain systems. Future Generation Computer Systems, 107, 841–853.

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[15] Yermack, D. (2017). Corporate governance and blockchains. Review of Finance, 21(1), 7–31.

to provide a detailed analysis of the role of cryptography as an institutional mechanism of trust in the digital economy. The research design is based on a comparative analysis of digital and traditional economic institutions, using descriptive statistical data to identify patterns and structures, as well as institutional analysis to gain deeper insights into the functions and mechanisms of trust across different economic systems[16]. For the purposes of this study, secondary data were used from relevant scholarly articles, reports from international organizations, and databases on the market and institutional frameworks of digital platforms, allowing a precise description of the phenomenon without the need for primary data collection. In addition, case studies were conducted focusing on specific blockchain platforms and digital financial systems as representative examples of modern institutional innovations[17]. This multi-source approach enables a comparative analysis of institutions and their specific roles in creating trust and reducing transaction costs. Analytical methods include comparative analysis, which examines the characteristics of traditional and cryptographic institutional mechanisms; institutional analysis, which investigates formal and informal structures affecting trust; and descriptive statistics, which present empirical patterns and trends in the use of digital trust mechanisms in economic transactions. Comparative analysis allows for the identification of key differences and similarities between institutional configurations in the digital economy and traditional systems, while descriptive statistics provide basic numerical indicators that support the interpretation of findings and conclusions[18]. Although this methodological approach allows for comprehensive analysis, certain limitations exist. First, reliance on secondary data may lead to dependency on the availability and quality of existing sources, which could limit precise quantification of some variables. Second, while case studies provide in-depth insights into specific examples, they may not be fully generalizable to all forms of digital economies, particularly given variations in legal and market frameworks across countries. Third, descriptive statistics are useful for identifying patterns but do not necessarily allow for causal inference without additional panel or experimental data[19]. Despite these limitations, the methodological approach provides a solid foundation for understanding the dynamics and institutional implications of cryptographic trust mechanisms in the digital economy.

Empirical Analysis and Results

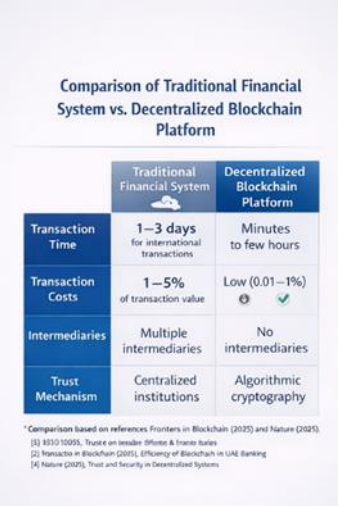

Diagram No. 2: Comparison of Traditional Financial Systems and Decentralized Blockchain Platforms

The empirical analysis clearly demonstrates the differences between traditional financial systems and decentralized blockchain platforms in terms of transaction costs, efficiency, and trust. Traditional financial systems, such as banks and global payment networks, are characterized by complex intermediary chains, high fees, and longer transaction processing times, particularly for international transfers. According to 2025 studies, the average processing time for an international transaction in a traditional system is up to three days, with costs ranging from 1 to 5 % of the transaction

[16] A preprint study comparing research methods in the social sciences highlights the importance of integrating quantitative and qualitative approaches for complex social phenomena (https://www.preprints.org/manuscript/202412.1128?utm_source=chatgpt.com, accessed 19 January 2026).

[17] Methodological studies on case studies in institutional economics demonstrate their advantages for analyzing complex institutional phenomena (https://link.springer.com/rwe/10.1007/978-3-031-50810-3_40?utm_source=chatgpt.com, accessed 19 January 2026).

[18] The comparative approach in economics enables understanding of institutional effects on economic outcomes through a combination of qualitative and quantitative analyses (https://www.researchgate.net/publication/383769710_Comparative_Analysis_of_Economic_Systems_and_Institutional_Frameworks_A_Cross-National_Study, accessed 19 January 2026).

[19] A critical review of descriptive designs highlights the limitations in drawing causal inferences without additional data and methods (https://www.sciencedirect.com/science/article/abs/pii/S0268401223000063?utm_source=chatgpt.com, accessed 19 January 2026).

value, which users often perceive as slow and expensive[20]. In contrast, decentralized blockchain-based platforms enable direct peer-to-peer transactions that can be completed within minutes to a few hours, without the need for centralized intermediaries and at significantly lower fees. Transaction cost analysis shows that blockchain implementation can reduce processing, transfer, and fraud-related costs by 30–50 %[21]. Beyond cost reduction, decentralized systems enhance transaction efficiency by enabling automatic verification and immutability of data, which accelerates processing and reduces administrative procedures. Cryptographic protocols, including smart contracts, encryption, and consensus algorithms, directly influence trust and transaction security. Blockchain infrastructure provides a transparent and immutable record of all transactions, eliminating the risk of manipulation and opportunistic behavior[22]. Smart contracts automatically execute contractual obligations once predefined conditions are met, reducing the need for intermediaries and legal intervention while providing users with mathematically verifiable trust in the system. The results indicate that decentralized platforms achieve significantly lower transaction costs and higher efficiency compared to traditional financial systems. Simultaneously, cryptographically secured protocols enhance trust and security, as verification and enforcement no longer depend on centralized institutions but on transparent and automatically verifiable mechanisms. These findings confirm the hypothesis that cryptography functions as an alternative institutional mechanism of trust in the digital economy, enabling faster, more secure, and more efficient transactions.

Theoretical Implications for Institutional Economics

The application of cryptographic technologies such as blockchain and smart contracts has profound theoretical implications for institutional economics, as institutions have traditionally shaped economic behavior through rules, norms, and mechanisms of trust. Within the framework of institutional economics, blockchain is increasingly viewed as an institutional technology that not only reduces transaction costs but also redefines the very nature of institutional arrangements[23].

Instead of relying on hierarchical or market mechanisms to address opportunism and uncertainty, as in the classical models of Oliver Williamson or North, blockchain introduces an algorithmically based framework of trust that can operate without centralized intermediaries. This shift carries significant theoretical consequences for the understanding of institutions: for the first time, an institution emerges in which rules, verification, and contract enforcement are grounded in mathematically verifiable protocols rather than solely in formal legal systems or reputational mechanisms of agent interactions[24]. Such institutional technology enables a new form of coordination and regulation of economic activities that is inherently global, transparent, and automated, expanding the analytical scope of traditional institutional theories. Furthermore, studies from 2024 and 2025 emphasize that blockchain does not eliminate the need for trust but rather transforms its sources and mechanisms: trust is no longer based exclusively on the reputation of the actor or legal authority, but also on cryptographic and consensus mechanisms that ensure the authenticity and immutability of transaction records[25]. This transformation opens the door to a theoretical expansion of institutional economics-from traditional institutions operating through formal and informal norms to hybrid institutional structures where technological protocols act as autonomous agents in economic coordination. Finally, the theoretical implications include the need to redefine the concept of trust itself, as blockchain mechanisms allow trust to be objectified through code-based, verifiable procedures, thereby reducing dependence on institutions whose authority is built on legitimacy or coercion. This represents a significant shift in institutional theory, challenging the traditional dichotomy between market and hierarchical coordination mechanisms and introducing a new dimension: algorithmic trust as an institutional construct.

Practical Implications for Digital Markets and the Financial Sector

The implementation of cryptographic technologies such as blockchain and smart contracts has concrete practical implications for digital markets and the financial sector, reflected in the transformation of business models, operational efficiency, and user trust. One of the most significant impacts is the reduction of transaction costs and processing times, particularly for cross-border payments, where traditional systems often involve multiple intermediaries and complex procedures, resulting in higher fees and delays[26]. The use of decentralized ledgers enables direct verification and transparent tracking of transactions in near real-time, reducing the need for centralized intermediaries and improving overall system efficiency. Furthermore, enhanced security and transparency represent key advantages for financial institutions and users in digital markets. Decentralized networks provide immutable records of transactions, minimizing the risk of data manipulation and fraud, while cryptographic methods

[20] Preprint study on cross-border transaction efficiency,2025. https://www.preprints.org/manuscript/202412.1128

[21] UAE banking sector blockchain implementation report, 2025. https://doi.org/10.3389/fbloc.2025.1551970

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[26] Catalini, C., & Gans, J. S., 2020. Some Simple Economics of the Blockchain: The Trust Machine.

such as encryption and consensus mechanisms contribute to system resilience against cyberattacks[27]. These characteristics increase trust among users and regulators, which is critical for the broader adoption of digital financial services and the attraction of institutional investment. Additionally, asset tokenization and the digitization of financial instruments open new opportunities for capital market access and increased liquidity, potentially leading to greater financial inclusion and innovation in product structuring[28]. Tokenization allows investors to purchase fractions or segments of high-value assets, such as real estate or bonds, which was not practical through traditional channels. These changes not only enhance market efficiency but also redefine the role of financial intermediaries, who are increasingly shifting toward functions of technical integration, risk management, and regulatory compliance rather than classical intermediation roles. However, despite these advantages, challenges and risks remain that the financial sector must address, including technological scalability, the need for interoperability with existing systems, and regulatory uncertainty, which may slow broader implementation. These practical implications require not only technological innovation but also the adaptation of business models, collaboration with regulators, and the development of new standards to enable the secure and sustainable adoption of cryptographic solutions within financial institutions.

Cryptography as a New Institutional Paradigm

Cryptography, particularly in the form of blockchain technology and smart contracts, is increasingly emerging as a new institutional paradigm in the digital economy. Traditional institutions, such as banks, regulatory bodies, and judicial systems, typically provide trust through formal rules, reputation, and enforcement. Cryptographic protocols, however, introduce an algorithmically grounded framework of trust, where the integrity of transactions and compliance with rules are ensured through mathematically verifiable procedures rather than centralized authority[29]. In this way, decentralized networks enable the coordination of economic activities without the need for traditional institutional intermediaries.

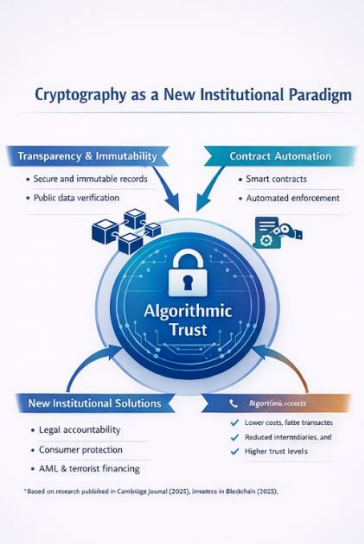

Diagram No. 3: Cryptography as a New Institutional Paradigm

This paradigm has several key implications for institutional economics. First, it redefines the concept of trust-it no longer relies solely on reputation or legal authority, but on the transparency and immutability of records in a distributed ledger and the automated execution of contractual obligations[30]. Second, cryptographic mechanisms reduce transaction costs and the risks of opportunism, as many aspects of monitoring and verification are automated, decreasing dependence on traditional institutions and their procedural limitations. Third, this new institutional paradigm opens space for innovation in business models and regulation, as it enables more flexible, faster, and globally interoperable trust mechanisms. Studies from 2024 and 2025 indicate that such systems can operate alongside existing institutional frameworks or even replace them in environments with weak or inefficient formal institutions[31]. This transformation implies that cryptography is no longer merely a technical tool for data protection,

[27] Mougayar, W., 2016. The Business Blockchain: Promise, Practice, and Application of the Next Internet Technology.

[28] Schär, F., 2021. Decentralized Finance: On Blockchain- and Smart Contract-Based Financial Markets, Federal Reserve Bank of St. Louis Review, 103(2), 153–174.

[29] Blockchain and smart contracts create an algorithmically based system of trust, enabling coordination without centralized intermediaries.
Daniil Frolov, Blockchain and institutional complexity: an extended institutional approach, Journal of Institutional Economics, Volume 17, Issue 1, February 2021, pp. 21–36, DOI: https://doi.org/10.1017/S1744137420000272

[30] Trust in cryptographic protocols redefines traditional mechanisms of institutional trust by relying on data transparency and immutability. https://www.sciencedirect.com/science/article/abs/pii/S0040162524003706?utm_source=chatgpt.com, accessed: 19.01.2026.

[31] Research from 2024–2025 emphasizes how blockchain paradigms can replace or complement weaker formal institutions, enabling a new dynamic of institutional trust. Haochen Guo & Xiaoxing Liu, Exploring trust dynamics in finance: the impact of blockchain technology and smart contracts, Humanities and Social Sciences Communications 12, 1235 (2025). https://doi.org/10.1057/s41599-025-05473-9

but fundamentally redefines institutional trust relationships in the digital economy, forming a new paradigmatic foundation for economic coordination and regulation.

Comparative Review of Existing Literature

A review of contemporary literature indicates that the concept of cryptography in institutional economics is evolving along several parallel research directions. On one hand, studies in the fields of blockchain technology and smart contracts emphasize the technical aspects of implementation and the efficiency of algorithmic trust in digital markets[32]. On the other hand, research in institutional economics focuses on redefining trust and transaction costs, highlighting how cryptographic protocols can replace or complement the roles of traditional intermediaries and regulatory bodies[33]. A comparative overview shows that while the technical literature examines security, decentralization, and automation in detail, the economic and institutional perspective provides a theoretical understanding of the implications for market organization and participant behavior. This differentiation points to a research gap: most empirical studies have yet to integrate both approaches-that is, to synthesize technical solutions with institutional and economic implications-leaving room for future research to develop a holistic model of digital trust and institutional efficiency.

Implications for Public Policy and Regulation

Diagram No. 4. Implications for Public Policy and Regulation

The application of cryptographic technologies, including blockchain and smart contracts, in the digital economy presents new regulatory challenges. Traditional regulatory frameworks are often not designed to accommodate decentralized and algorithmically based systems, creating legal uncertainty and potential risks for users and the financial sector[34]. Issues such as liability in the event of errors in smart contracts, consumer protection, anti-money laundering, and counter-terrorism financing require the development of new legal mechanisms that can keep pace with the dynamics of decentralized networks without compromising their fundamental principles of transparency and immutability. Balancing innovation, security, and oversight represents a key challenge for policymakers. Overly restrictive regulations can slow innovation and reduce the competitiveness of digital markets, while under-regulated systems increase the risk of abuse and undermine user trust[35]. Therefore, it is essential to establish flexible regulatory approaches, including sandbox models, which allow new technologies to be tested under regulatory supervision before full commercialization. The role of national governments and international institutions in this paradigm is multifaceted. States can create legislative frameworks that define the rules of the game, interoperability standards, and user protection

[32] Recent studies highlight blockchain and smart contract implementations as mechanisms for algorithmic trust in digital markets, emphasizing efficiency, transparency, and automation. Jeffrey G. Bell and Thomas C. Underwood, Unconventional and Emerging Approaches to CO2 Reduction, https://doi.org/10.3390/su16020713, accessed: 19.01.2026.

[33] Economic and institutional literature emphasizes the potential of cryptographic protocols to reduce transaction costs and replace traditional intermediaries, highlighting their implications for market organization and trust. Daniil Frolov, Blockchain and Institutional Complexity: An Extended Institutional Approach, Journal of Institutional Economics, Volume 17, Issue 1, February 2021, pp. 21–36, DOI: https://doi.org/10.1017/S1744137420000272

[34] Recent analyses highlight the regulatory uncertainty around decentralized and cryptographically secured systems, including legal accountability and consumer protection issues. Jeffrey G. Bell and Thomas C. Underwood, Unconventional and Emerging Approaches to CO2 Reduction, Special Issue Sustainable Electrochemical Materials and Processes, https://doi.org/10.3390/su16020713, preuzeto: 19.01.2026.

[35] Literature emphasizes the need to balance innovation and security, recommending flexible regulatory sandboxes to test blockchain applications under supervision. Ibrahim Elsiddig Ahmed, Analyzing the impact of blockchain technology on banking transaction costs using the random forest method, Sec. Financial Blockchain, Volume 8 - 2025 https://doi.org/10.3389/fbloc.2025.1551970

procedures, while international institutions and regulatory bodies can coordinate cross-border regulations and standards, as the digital nature of cryptographic systems transcends national boundaries[36]. Global coordination is particularly important to prevent regulatory arbitrage and preserve the integrity of the financial system. Based on the analysis of existing literature and empirical findings, the following recommendations for policymakers can be proposed:

- Develop flexible and adaptive regulatory frameworks that enable experimentation and innovation;
- Implement consumer protection mechanisms specific to digital and decentralized systems;
- Establish interoperability standards between different blockchain and digital platforms;
- Coordinate international regulatory efforts to reduce market fragmentation;
- Support research and development that integrates technical, economic, and institutional aspects of digital trust.

These recommendations highlight the need for a proactive, multidisciplinary approach to regulating cryptographically based systems, combining technological, economic, and legal perspectives to support a secure and innovative digital economy.

Conclusion

The conclusion of this study synthesizes the key findings and highlights the significance of cryptography as an institutional mechanism of trust in the contemporary digital economy. The analysis demonstrates that cryptographic protocols, including blockchain infrastructure, smart contracts, and consensus algorithms, enable the creation of a transparent, immutable, and mathematically verifiable system of trust. This system significantly reduces transaction costs, the risk of opportunistic behavior, and the reliance on centralized intermediaries. The empirical section of the study confirms that decentralized platforms, compared to traditional financial systems, facilitate faster and cheaper transactions while enhancing the security and reliability of digital interactions. With respect to the research question, the study shows that cryptography functions as an effective substitute for traditional institutions in generating trust, while also establishing a new institutional paradigm that redefines the relationships between actors and institutions in the digital economy. This finding implies that trust is no longer solely a social or legal construct but also a technologically grounded resource that can be formalized and automated through cryptographic protocols. The scientific contribution of this work lies in integrating theoretical approaches from new institutional economics, transaction cost theory, and economic models of trust with the technical aspects of cryptography. The study provides a holistic perspective on the functional role of cryptographic technologies in creating institutional trust and offers empirical evidence of their impact on digital market efficiency and the transformation of financial institutions. In this way, the research contributes to understanding how digital infrastructure can shape economic coordination and regulation in a modern digital environment. Future research directions include deeper empirical analyses of different blockchain network models and smart contracts across various economic sectors, examining the impact of decentralized systems on international regulations and standards, and developing integrated theoretical models that combine technical, institutional, and economic aspects of trust. Additionally, it is recommended to investigate the social and ethical implications of implementing cryptographic technologies, including issues of privacy, digital inclusion, and potential economic stratification, which would further strengthen the theoretical and practical frameworks for applying these technologies in the digital economy.

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[36] International coordination is crucial to address cross-border regulatory challenges and prevent market fragmentation in decentralized financial systems. Haochen Guo & Xiaoxing Liu, Exploring trust dynamics in finance: the impact of blockchain technology and smart contracts, Humanit Soc Sci Commun 12, 1235 (2025). https://doi.org/10.1057/s41599-025-05473-9.

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THE IMPACT OF NON-FINANCIAL MOTIVATION PRACTICES ON EMPLOYEE ENGAGEMENT: EVIDENCE FROM HUAWEI

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Abstract

Non-financial motivation practices have attracted increasing attention in high-technology enterprises where knowledge workers value recognition, autonomy, and career development. Huawei Technologies, as one of China's leading technology firms, has developed a distinctive management culture that emphasizes responsibility, learning, and internal growth rather than relying solely on monetary rewards. This study explores how non-financial motivation practices influence employee engagement at Huawei. Using a qualitative case study approach based on secondary data, corporate reports, and existing academic research, the paper analyzes the relationship between recognition mechanisms, career development systems, and employee engagement. The findings indicate that non-financial motivation plays a significant role in fostering employees' emotional attachment and proactive behavior, although excessive pressure embedded in the organizational culture may partially weaken these positive effects.

Keywords: non-financial motivation; employee engagement; Huawei Technologies; recognition; career development.

1. Introduction

Employee engagement has become a strategic concern for high-technology companies that rely on knowledge workers and innovation. While financial incentives remain important, scholars argue that non-financial factors such as recognition, meaningful work, and personal growth opportunities are critical drivers of long-term engagement (Kahn, 1990; Saks, 2006).

Huawei Technologies provides an interesting research context because of its strong internal culture, emphasis on learning, and unique management philosophy. Although Huawei is often associated with high performance pressure, it also invests heavily in employee development, internal promotion, and recognition programs. This study examines how Huawei's non-financial motivation practices affect employee engagement.

2. Literature Review

2.1 Non-Financial Motivation Practices

Non-financial motivation refers to management practices that enhance employees' intrinsic motivation rather than directly increasing pay. These practices include recognition, career development, participation in decision-making, training opportunities, and organizational support (Armstrong, 2012).

Herzberg's two-factor theory suggests that motivators such as achievement and recognition are more closely related to job satisfaction and engagement than hygiene factors like salary (Herzberg, Mausner, & Snyderman, 1959).

2.2 Employee Engagement

Employee engagement is defined as a positive, fulfilling work-related state characterized by vigor, dedication, and absorption (Schaufeli, Salanova, González-Romá, & Bakker, 2002). Research consistently shows that engaged employees are more productive and less likely to leave their organizations (Saks, 2006).

3. Methodology

This study adopts a qualitative case study approach focusing on Huawei Technologies. Data were collected from Huawei's annual reports, corporate publications, interviews published in business media, and relevant academic literature. The aim is to identify major non-financial motivation practices at Huawei and analyze their influence on employee engagement.

4. Non-Financial Motivation Practices at Huawei

Huawei has established several non-financial mechanisms designed to enhance employees' sense of value and belonging.

Table 1.

Key Non-Financial Motivation Practices at Huawei

Practice Type	Description	Expected Influence on Engagement
Recognition System	Internal awards and public recognition for outstanding work	Strengthens emotional attachment
Career Development	Clear promotion paths and internal mobility	Enhances long-term commitment
Training Programs	Huawei University and continuous learning platforms	Improves skill confidence
Participation	Employee involvement in project decision-making	Increases psychological ownership

5. Discussion

Huawei's emphasis on recognition and learning aligns with Herzberg's (1959) motivator factors. According to Zhang and Morris (2014), Chinese technology firms that provide structured career development paths achieve higher engagement levels among young engineers. Huawei's internal promotion culture reinforces employees' belief that effort leads to growth, which strengthens engagement.

However, the company's well-known "struggle culture" also embeds high performance expectations. While such pressure may stimulate dedication in the short term, prolonged stress can reduce emotional well-being (Li & Huang, 2017). Kahn (1990) argues that employees engage more deeply when they feel psychologically safe, suggesting that non-financial motivation practices must be balanced with supportive management.

6. Conclusion

This study investigated the impact of non-financial motivation practices on employee engagement at Huawei Technologies. The findings suggest that recognition systems, career development opportunities, and training programs significantly enhance employee engagement by fulfilling employees' intrinsic needs for growth and acknowledgment. Nevertheless, excessive work pressure may offset these positive effects. For sustainable engagement, high-technology firms should integrate non-financial motivators with humane management practices.

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CHALLENGE–HINDRANCE STRESSORS AND EMPLOYEE INNOVATION: DOES PERFORMANCE PRESSURE MAKE A DIFFERENCE?

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Abstract

Employee innovation is widely recognized as a critical driver of organizational competitiveness and long-term performance. However, employees often face various work-related stressors that shape their ability and willingness to engage in innovative behavior. Drawing on the challenge–hindrance stressor framework, this paper examines how different types of stressors influence employee innovation and explores whether performance pressure plays a differentiating role in this relationship. Challenge stressors, such as workload and responsibility, are generally associated with learning and growth, whereas hindrance stressors, such as role ambiguity and organizational politics, tend to obstruct performance and well-being. This paper argues that performance pressure can amplify or weaken the effects of these stressors on innovative behavior depending on how it is experienced by employees. By integrating stress theory and innovation research within a management context, this study develops a conceptual framework and discusses theoretical and managerial implications for fostering innovation under demanding work conditions.

Keywords: challenge stressors; hindrance stressors; performance pressure; employee innovation; organizational behavior.

1. Introduction

Innovation has become a strategic priority for organizations operating in increasingly dynamic and competitive environments. To stimulate innovation and improve efficiency, managers frequently impose demanding performance goals and tight deadlines. As a result, employees are exposed to multiple sources of work stress that can influence their attitudes and behaviors.

Research in organizational behavior has long acknowledged that stress is an inherent part of work life. However, studies examining the relationship between stress and innovation have produced mixed findings. While some research suggests that stress can motivate employees to search for novel solutions, other studies indicate that stress undermines creativity by consuming cognitive and emotional resources.

To reconcile these inconsistencies, scholars have increasingly adopted the challenge–hindrance stressor framework, which distinguishes between stressors that promote growth and those that impede goal achievement (Cavanaugh et al., 2000). Despite its explanatory power, relatively little attention has been paid to how performance pressure interacts with challenge and hindrance stressors in shaping employee innovation.

This paper addresses this gap by examining whether performance pressure makes a difference in the relationship between challenge–hindrance stressors and employee innovative behavior. From a management perspective, understanding this relationship is essential for designing performance systems that encourage innovation rather than suppress it.

2. Literature Review

2.1 Challenge and Hindrance Stressors

The challenge–hindrance stressor framework categorizes job stressors based on how they are perceived by employees (Cavanaugh et al., 2000). Challenge stressors include demands such as high workload, time pressure, and job responsibility. Although these stressors require effort, they are associated with opportunities for learning, achievement, and personal growth.

In contrast, hindrance stressors refer to demands that constrain or interfere with work accomplishment, such as role ambiguity, organizational politics, and job insecurity. These stressors are typically perceived as obstacles that employees have little control over, leading to frustration and withdrawal.

Empirical studies in management research have shown that challenge stressors are positively related to motivation and performance, whereas hindrance stressors are negatively associated with job satisfaction and well-being (LePine et al., 2005).

2.2 Employee Innovation

Employee innovation involves the generation, promotion, and implementation of novel and useful ideas in the workplace (Janssen, 2000). Unlike routine

task performance, innovative behavior requires employees to experiment, question established practices, and tolerate uncertainty.

Because innovation entails risk and potential failure, employees' engagement in innovative behavior is particularly sensitive to work stressors. Challenge stressors may energize employees and stimulate problem-solving, whereas hindrance stressors are likely to deplete cognitive resources and reduce willingness to take risks.

2.3 Performance Pressure in Organizations

Performance pressure refers to employees' perceptions of the intensity of performance expectations and evaluation in their work environment (Podsakoff et al., 2007). In management practice, performance pressure is often introduced through performance appraisal systems, incentive schemes, and competitive ranking mechanisms.

Performance pressure can function as a motivational force by increasing goal focus and urgency. However, when perceived as excessive or punitive, it may heighten anxiety and fear of failure. This dual nature suggests that performance pressure may alter how employees respond to challenge and hindrance stressors.

3. Theoretical Framework

3.1 Stress and Innovation from a Management Perspective

According to stress theory, employees respond to job demands based on their appraisal of whether these demands exceed their coping resources (Lazarus & Folkman, 1984). In organizational settings, this appraisal process determines whether stress leads to constructive or dysfunctional outcomes.

Challenge stressors are more likely to be appraised as manageable and meaningful, thereby promoting engagement and exploration. Hindrance stressors, in contrast, are typically appraised as uncontrollable threats, which inhibit learning and innovation.

3.2 The Role of Performance Pressure

Performance pressure may shape the strength of these relationships. Under moderate performance pressure, challenge stressors may become more salient and motivating, encouraging employees to innovate in order to meet high expectations. In this sense, performance pressure can reinforce the positive effects of challenge stressors on innovation.

However, high performance pressure may exacerbate the negative effects of hindrance stressors. When employees feel that mistakes will be punished and failure is unacceptable, they are more likely to avoid experimentation and focus on self-protection. Thus, performance pressure can intensify the detrimental impact of hindrance stressors on innovative behavior.

4. Conceptual Model and Key Variables

Table 1.

Key Constructs in the Conceptual Framework

Variable	Type	Description
Challenge Stressors	Independent Variable	Work demands perceived as opportunities for growth
Hindrance Stressors	Independent Variable	Work demands perceived as obstacles or constraints
Performance Pressure	Contextual Variable	Intensity of performance expectations and evaluation
Employee Innovation	Dependent Variable	Generation and implementation of new ideas

The proposed framework suggests that challenge stressors and hindrance stressors have different effects on employee innovation, and that performance pressure influences the strength and direction of these effects.

5. Discussion

5.1 Theoretical Implications

This paper contributes to the organizational behavior and management literature in several ways. First, it extends the challenge–hindrance stressor framework by explicitly incorporating performance pressure as a contextual factor. This helps explain why similar stressors may lead to different innovation outcomes across organizational settings.

Second, the study highlights the importance of distinguishing between types of stressors rather than treating stress as a uniform construct. By doing so, it provides a more nuanced understanding of how work demands shape innovative behavior.

5.2 Managerial Implications

For managers, the findings suggest that stress cannot be eliminated from the workplace, nor should it be. Instead, managers should focus on increasing challenge stressors while minimizing hindrance stressors. Additionally, performance pressure should be carefully calibrated to motivate innovation without creating a climate of fear.

Practices such as clear role definitions, transparent evaluation criteria, and supportive leadership can help ensure that performance pressure enhances rather than undermines employee innovation.

6. Conclusion

This paper examines the relationship between challenge–hindrance stressors and employee innovation, with a particular focus on the role of performance pressure. It argues that performance pressure makes a critical difference by shaping how employees respond to different types of stressors. While challenge stressors may promote innovation under appropriate performance pressure, hindrance stressors are likely to suppress innovation, especially in high-pressure environments.

Future research could empirically test the proposed framework and explore additional moderating variables, such as leadership style or psychological safety. Overall, this study underscores the importance of balanced stress management in fostering sustainable innovation within organizations.

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КОММУНИКАЦИОННЫЕ РИСКИ В УСЛОВИЯХ РЕПУТАЦИОННОГО ДАВЛЕНИЯ В НЕФТЕГАЗОХИМИЧЕСКОМ СЕКТОРЕ

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COMMUNICATION RISKS UNDER REPUTATIONAL PRESSURE IN THE PETROCHEMICAL SECTOR

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Аннотация

В условиях усиления общественного внимания, экологической чувствительности и цифровой прозрачности компании нефтегазохимического сектора функционируют под постоянным репутационным давлением. В этих условиях коммуникационные риски становятся одним из ключевых факторов, влияющих на устойчивость компаний, доверие стейкхолдеров и эффективность управленческих решений. В статье рассматриваются теоретические подходы к пониманию коммуникационных рисков и анализируется их взаимосвязь с репутационным давлением в нефтегазохимическом секторе. На основе международных моделей кризисных коммуникаций, стейкхолдер-подхода и теорий управления репутацией показано, каким образом недостатки коммуникаций способны трансформировать локальные инциденты в масштабные репутационные угрозы. Особое внимание уделяется роли интеграции функций PR, GR и IR, обоснованной в статье как ключевой механизм снижения коммуникационных рисков и повышения устойчивости компаний в условиях репутационного давления. Результаты исследования могут быть использованы в качестве методологической основы для дальнейших прикладных исследований и разработки корпоративных систем управления коммуникационными рисками.

Abstract

In the context of increased public attention, environmental sensitivity, and digital transparency, companies operating in the petrochemical sector function under constant reputational pressure. Under these conditions, communication risks become one of the key factors influencing corporate sustainability, stakeholder trust, and the effectiveness of managerial decision-making. The article examines theoretical approaches to understanding communication risks and analyses their relationship with reputational pressure in the petrochemical sector. Based on international crisis communication models, the stakeholder approach, and reputation management theories, the study demonstrates how deficiencies in communication can transform local incidents into large-scale reputational threats. Particular attention is paid to the integration of PR, GR, and IR functions, which is substantiated in the article as a key mechanism for reducing communication risks and enhancing corporate sustainability under reputational pressure. The findings of the study may be used as a methodological basis for further applied research and the development of corporate communication risk management systems.

Ключевые слова: коммуникационные риски, репутационное давление, кризисные коммуникации, управление репутацией, стейкхолдеры, нефтегазохимический сектор, PR, GR, IR.

Keywords: communication risks, reputational pressure, crisis communication, reputation management, stakeholders, petrochemical sector, PR, GR, IR.

Введение

Современная информационная среда характеризуется высокой скоростью распространения информации, доминированием цифровых каналов коммуникации и ростом общественного внимания к вопросам экологической и социальной ответственности бизнеса. Компании нефтегазохимического сектора функционируют в условиях постоянного контроля со стороны государства, местных сообществ, средств массовой информации, общественных организаций и международных институтов. В результате коммуникации перестают быть вспомогательной функцией и приобретают

стратегическое значение в системе корпоративного управления.

В этих условиях коммуникационные риски становятся важнейшим фактором, определяющим восприятие деятельности компании стейкхолдерами. Несвоевременные, непоследовательные или недостаточно прозрачные коммуникации способны существенно усилить репутационное давление, трансформируя отдельные инциденты в системные кризисы. Данная проблема особенно актуальна для нефтегазохимического сектора, традиционно воспринимаемого как социально и экологически чувствительный.

Целью статьи является анализ коммуникационных рисков в условиях репутационного давления и систематизация теоретических подходов, объясняющих их взаимосвязь в контексте нефтегазохимического сектора.

Дополнительную актуальность исследуемой проблематике придаёт трансформация общественных ожиданий в отношении крупных промышленных проектов. В нефтегазохимическом секторе репутационное давление формируется не только в ответ на реальные инциденты, но и под влиянием ожиданий, связанных с экологической безопасностью, социальной ответственностью, трудовыми отношениями и прозрачностью управленческих решений. В условиях цифровизации и высокой медиатизации любое управленческое решение может быть интерпретировано через призму репутационных рисков, даже при отсутствии прямых нарушений со стороны компании. Это обуславливает необходимость рассмотрения коммуникационных рисков не как реактивного инструмента кризисного реагирования, а как проактивного элемента системы корпоративного управления и устойчивого развития.

1. Коммуникационные риски как объект теоретического анализа

В научной литературе коммуникационные риски рассматриваются как риски, возникающие вследствие ошибок, искажений или несогласованности информационного обмена между организацией и её стейкхолдерами (Coombs, 2007; Heath & O'Hair, 2020). Данные риски проявляются как на этапе формирования сообщений, так и на этапе их интерпретации, что придаёт им социально-психологический характер.

Международные исследования подчёркивают, что коммуникационные риски часто выступают механизмом трансформации операционных, социальных или экологических инцидентов в репутационные угрозы (Benoit, 1995; Coombs, 2014). Качество коммуникаций во многом определяет, воспринимается ли ситуация как управляемая или, напротив, как свидетельство системных проблем в деятельности компании.

Для нефтегазохимического сектора коммуникационные риски тесно связаны с экологическими ожиданиями общества, социально-трудовыми отношениями и регуляторным давлением. В этой связи они должны рассматриваться как элемент общей системы управления рисками, а не как изолированная категория.

В рамках риск-ориентированного подхода коммуникационные риски целесообразно рассматривать как составную часть корпоративной системы управления рисками. Международные стандарты, включая ISO 31000, подчёркивают значение коммуникации и консультаций как обязательного элемента всех этапов риск-менеджмента – от идентификации до мониторинга рисков. В данном контексте коммуникационные риски выступают связующим звеном между техническими, социальными и управленческими рисками, поскольку именно через коммуникацию формируется восприятие рисков различными группами стейкхолдеров. Для нефтегазохимических компаний это означает, что даже эффективно управляемые технологические или экологические риски могут трансформироваться в репутационные угрозы при отсутствии системной коммуникационной политики.

2. Репутационное давление и его влияние на коммуникационные риски

Репутация компании в современных условиях выступает стратегическим активом, отражающим совокупное восприятие организации её стейкхолдерами (Fombrun, 1996; Doorley & Garcia, 2015). В социально и экологически чувствительных отраслях репутация формируется под воздействием постоянных ожиданий и оценок, создающих состояние устойчивого репутационного давления.

Репутационное давление отличается от репутационного риска тем, что представляет собой уже существующую среду повышенного внимания и контроля, а не вероятность негативного события. Оно формируется под влиянием экологической повестки, требований к социальной ответственности, регуляторных ожиданий, медийных нарративов и цифровой активности.

Важно отметить, что репутационное давление носит кумулятивный характер и накапливается со временем. Даже при отсутствии острых кризисов компании нефтегазохимического сектора функционируют в условиях постоянного сравнения с отраслевыми и международными стандартами, ожиданиями инвесторов, требованиями регуляторов и общественными представлениями о допустимых уровнях экологического и социального воздействия. В этой связи репутационное давление формирует своего рода «фон повышенной чувствительности», при котором любые коммуникационные сбои воспринимаются более остро и быстрее приобретают публичный характер. Это существенно повышает значимость превентивных коммуникационных стратегий и системного мониторинга информационной среды.

Коммуникационные риски в этих условиях приобретают ключевое значение. Недостаточная прозрачность, запоздалая реакция или оборонительные коммуникационные стратегии усиливают репутационное давление, тогда как проактивные и согласованные коммуникации способны смягчить

негативное восприятие даже при наличии объективных рисков.

3. Кризисные коммуникации и стейкхолдерский подход

Теоретической основой анализа коммуникационных рисков в условиях репутационного давления являются модели кризисных коммуникаций. В частности, Теория ситуативной кризисной коммуникации (SCCT) подчёркивает, что реакция стейкхолдеров зависит от степени ответственности, приписываемой организации за произошедшее событие (Coombs, 2007). Для нефтегазохимических компаний характерно восприятие многих кризисных ситуаций как предотвратимых, что повышает чувствительность общества к качеству коммуникаций.

Теория восстановления имиджа (Benoit, 1995) дополняет данный подход, предлагая набор коммуникационных стратегий, направленных на восстановление доверия. Эффективность этих стратегий определяется ожиданиями стейкхолдеров и предшествующей репутацией компании.

Стейкхолдер-подход (Freeman, 1984) подчёркивает необходимость учёта разнообразия интересов и интерпретаций различных групп. В нефтегазохимическом секторе ключевыми стейкхолдерами являются государственные органы, местные сообщества, трудовые коллективы, подрядчики, СМИ и международные партнёры. Это усиливает значение интеграции внешних (PR, GR) и внутренних (IR) коммуникаций в единую управленческую систему.

4. Обсуждение: специфика нефтегазохимического сектора

Проведённый анализ показывает, что коммуникационные риски и репутационное давление находятся во взаимозависимой связи. Коммуникационные сбои усиливают репутационное давление, а устойчивое репутационное давление, в свою очередь, повышает последствия любых коммуникационных ошибок.

Для нефтегазохимических компаний Казахстана данная взаимосвязь усугубляется высокой ролью государства, социально-трудовой чувствительностью и активным развитием цифровых медиа. В этих условиях особое значение приобретает внутренняя коммуникационная среда и работа с персоналом и подрядчиками (IR), которая нередко становится источником репутационных сигналов.

Отдельного внимания заслуживает роль внутреннего контура коммуникаций в формировании репутационного давления. В нефтегазохимических проектах значительная часть репутационных сигналов возникает внутри компании – в трудовых коллективах, среди подрядчиков и субподрядных организаций. Социально-трудовые вопросы, условия занятости, безопасность труда и прозрачность управленческих решений нередко становятся источниками информационных поводов, выходящих за пределы корпоративного периметра. В этой связи функция IR приобретает стратегическое значение, поскольку позволяет выявлять потенциальные конфликтные зоны на ранних этапах и предотвращать их эскалацию в публичное пространство. Недооценка данного контура приводит к тому, что локальные внутренние проблемы трансформируются в репутационные кризисы внешнего уровня.

Интеграция функций PR, GR и IR позволяет обеспечить раннее выявление проблемных зон, выстроить диалог со стейкхолдерами и предотвратить эскалацию локальных конфликтов в масштабные репутационные кризисы.

Заключение

Коммуникационные риски в условиях репутационного давления выступают одним из ключевых факторов, определяющих устойчивость компаний нефтегазохимического сектора. Специфика отрасли, связанная с высокой экологической и социальной чувствительностью, усиливает влияние качества коммуникаций на восприятие деятельности компании со стороны различных групп стейкхолдеров. В этих условиях любые коммуникационные сбои способны оказывать непропорционально сильное воздействие на репутацию и доверие к организации.

Репутационное давление формирует устойчивую среду повышенных ожиданий и внешнего контроля, в рамках которой последствия коммуникационных ошибок многократно усиливаются. В отличие от репутационного риска, представляющего собой вероятность наступления негативного события, репутационное давление является постоянным фактором внешнего воздействия, влияющим на интерпретацию управленческих решений и информационных поводов независимо от их объективной значимости.

Международные модели кризисных коммуникаций и управления репутацией предоставляют эффективный теоретический инструментарий для анализа взаимосвязи коммуникационных рисков и репутационного давления. Подходы, основанные на Теории ситуативной кризисной коммуникации, теории восстановления имиджа и стейкхолдер-анализе, позволяют системно рассматривать механизмы эскалации кризисов и оценивать влияние коммуникационных стратегий на уровень общественного доверия.

Полученные результаты подтверждают, что снижение коммуникационных рисков не может быть достигнуто исключительно за счёт реактивных мер кризисного характера. В условиях устойчивого репутационного давления требуется переход к интегрированной модели коммуникационного управления, ориентированной на превентивное выявление рисков, согласованность сообщений и системную работу со стейкхолдерами. Такая модель предполагает институционализацию взаимодействия функций PR, GR и IR на уровне стратегического управления и включение коммуникационных факторов в общую архитектуру корпоративного риск-менеджмента.

Сформулированные выводы создают методологическую основу для дальнейших прикладных исследований и разработки практических рекомендаций, направленных на совершенствование систем управления коммуникационными рисками в нефтегазохимическом секторе.

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MEDICAL SCIENCES

SOCIAL AND PSYCHOLOGICAL ADAPTATION IN PATIENTS WITH COLOSTOMY: A SYSTEMATIC REVIEW

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Abstract

Colostomy is a life-altering surgical intervention that profoundly affects patients' physical integrity, emotional balance, and social participation. Beyond clinical recovery, individuals with colostomy frequently face psychological distress, altered body image, and social withdrawal. Consequently, social and psychological adaptation has become a core outcome in contemporary stoma care.

This systematic review aims to synthesize recent scientific evidence regarding social and psychological adaptation in patients with colostomy, with a particular focus on clinical determinants, nursing interventions, and medical psychology approaches.

The systematic review was conducted in accordance with PRISMA guidelines. Electronic databases including PubMed, Scopus, and Web of Science were searched for studies published between January 2020 and December 2024. Inclusion criteria targeted peer-reviewed studies involving adult patients with colostomy and reporting outcomes related to psychosocial adaptation, quality of life, or supportive interventions.

A total of 21 studies met the inclusion criteria. Findings indicate that psychological adaptation is strongly influenced by clinical stability, self-care competence, structured nursing education, and access to psychological support. Nursing-led educational programs and psychological interventions were consistently associated with reduced emotional distress, improved self-efficacy, and enhanced social reintegration.

Conclusions: Social and psychological adaptation in patients with colostomy is a multidimensional and dynamic process. Integrated interdisciplinary care combining clinical management, nursing support, and psychological interventions significantly improves long-term outcomes and quality of life.

Keywords: colostomy; psychosocial adaptation; nursing care; medical psychology; quality of life.

1. INTRODUCTION

Colostomy represents a life-saving surgical solution for patients affected by colorectal cancer, inflammatory bowel disease, or severe intestinal trauma. While the procedure is often essential for survival, it introduces permanent changes in bodily function, appearance, and daily routines. These changes frequently challenge patients' emotional stability, self-perception, and social participation.

Recent research highlights that successful postoperative outcomes cannot be evaluated solely through physiological indicators. Instead, social and psychological adaptation has emerged as a critical determinant of recovery, treatment adherence, and long-term quality of life. Patients with colostomy often experience anxiety, depressive symptoms, body image dissatisfaction, and fear of social rejection, underscoring the need for comprehensive and holistic care.

2. METHODS

This systematic review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) recommendations. Electronic searches were performed in PubMed, Scopus, and Web of Science databases. Search terms included combinations of: colostomy, ostomy, psychological adaptation, social adaptation, nursing care, psychological support, and quality of life. Studies published between January 2021 and December 2025 were considered.

Inclusion criteria were:

- peer-reviewed original research or reviews;
- adult patients (≥18 years) with temporary or permanent colostomy;
- outcomes related to social or psychological adaptation, emotional well-being, or quality of life.

Exclusion criteria included case reports, non-English publications, pediatric populations, and studies lacking psychosocial outcomes.

3. RESULTS

Clinical Determinants of Adaptation

Across the reviewed studies, clinical factors such as postoperative complications, stoma-related symptoms, and comorbidities were strongly associated with psychological outcomes. Patients experiencing leakage, skin irritation, or persistent discomfort reported higher levels of anxiety, depression, and social avoidance. Conversely, effective symptom control and clinical stability facilitated emotional adjustment and social engagement.

Nursing Interventions and Adaptive Outcomes

Nursing care emerged as a central component in promoting psychosocial adaptation. Structured nursing education programs focusing on stoma care, complication prevention, and daily management significantly enhanced patients' self-care competence and confidence. Continuous nurse–patient interaction, therapeutic communication, and individualized education reduced uncertainty and stigma-related fears.

Patients receiving consistent nursing support demonstrated improved autonomy, reduced emotional

distress, and greater participation in social and professional activities.

Medical Psychology and Psychosocial Adaptation

From a medical psychology perspective, adaptation involves acceptance of bodily changes, emotional regulation, and reconstruction of personal identity. Several studies highlighted the prevalence of body image disturbances, social anxiety, and fear of rejection among colostomy patients.

Psychological interventions, including counseling, cognitive-behavioral therapy, and peer support groups, were associated with reduced depressive symptoms, enhanced coping strategies, and improved long-term psychological well-being.

4. DISCUSSION

The findings of this review confirm that social and psychological adaptation in patients with colostomy is a continuous, multifactorial process influenced by clinical, emotional, and social variables. Isolated clinical management is insufficient to address the complex needs of this population.

Interdisciplinary collaboration among surgeons, nurses, and psychologists is essential for optimizing outcomes. Holistic care models that integrate physical treatment with psychosocial support align with current patient-centered healthcare paradigms and demonstrate superior results in quality of life and functional independence.

5. CONCLUSIONS

Adaptation to colostomy extends far beyond surgical recovery and represents a fundamental component of comprehensive patient care. Clinical stability, nursing-led education, and psychological support jointly determine adaptive success. Implementing integrated interdisciplinary strategies should be considered standard practice to enhance social participation, emotional well-being, and long-term quality of life in patients living with colostomy.

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THE ROLE OF ATYPICAL LYMPHOCYTES IN DIAGNOSIS OF EBV INFECTIOUS MONONUCLEOSIS

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Abstract

Infectious mononucleosis (IM) results from an initial Epstein–Barr virus (EBV) infection and usually shows an atypical lymphocytosis on a peripheral blood smear; however, some aspects—including the diagnostic sensitivity, specificity, timing, and cellular identity of atypical lymphocytes versus their serologic or heterophile test results—are still being discussed in the medical community.

This review will look at the morphology, immune phenotype, kinetic characteristics, diagnostic capability, and practical applications of atypical lymphocytes in IMM/EBV; it is based on prior studies of their immunophenotype (Pattengale et al., 1974; Callan et al., 1996), diagnostic performance (AAFP, StatPearls), and newly published literature regarding the automated analyzer index (high-fluorescence lymphocytes/HFLC

Keywords: Epstein–Barr virus; infectious mononucleosis; atypical lymphocytes; Downey cells; heterophile antibodies; Monospot; CD8 T lymphocytes.

I. Introduction

The Epstein-Barr virus (EBV), which is a widespread herpes virus, typically causes infectious mononucleosis (IM) when adolescents and young adults are infected with the virus for the first time. The clinical symptoms of IM include fever, sore throat, swollen lymph nodes around the neck, and extreme tiredness. The AAFP indicates that one of the most frequently used laboratory indicators of IM is the presence of an elevated number of lymphocytes found in the peripheral blood, along with a subset of lymphocytes that have a different appearance than typical lymphocytes. These lymphocytes are known as 'atypical lymphocytes' or 'reactive lymphocytes' or 'Downey cells,' and they can be seen using blood smears and microscopy. (Sylvester et al., 2023)

Atypical lymphocytes are significant for diagnosis due to their immediate availability when evaluating routine blood smears, and they also play a role in determining the application and interpretation of rapid heterophile (Monospot) tests and EBV-specific serology. However, detailed understanding of the diagnostic accuracy, source of atypical lymphocytes, and their temporal relationship to symptoms have only been understood through the use of advanced immunophenotyping and molecular techniques. (Pattengale, Smith, & Perlin, 1974)

II. Methods

Reference resources. I searched through PubMed/NCBI, publisher websites and clinical review and analysis articles for the terms "Atypical Lymphocytes Epstein Barr Virus", "Downey Cells", "Monospot Sensitivity", "Pattengale 1974", "Callan 1996 CD8", and "High Fluorescence Lymphocyte Count HFLC". I prioritized (1) original research on the immunophenotype/molecular characterization of the identity of atypical lymphocytes, (2) diagnosis-performance studies and cohorts comparing smear/heterophile/serology, and (3) studies comparing automated analyzer flagging systems (HFLC/HFC) with manual counting of atypical

lymphocytes. I selected reputable, high visibility, recent sources for combining these articles. (Pattengale et al., 1974)

Selection Criteria and Outcome Extraction. Included articles reported either (a) the morphology/immunophenotype/clonality of atypical lymphocytes in patients with recent infectious mononucleosis; (b) sensitivity/specificity or timing data for atypical lymphocyte tests or heterophile tests; or (c) the performance of automated lymphocyte flags versus manually done smears. For primary studies, we extracted sample sizes and major findings (e.g., CD8 dominance, clonality) and diagnostic metrics, when available. (Pattengale et al., 1974)

Limitations: This narrative is a synthesis of selected key studies; not a systematic review with meta-analysis. Study heterogeneity (age, timing, laboratory methods) results in limitations to pooled estimates. (Courville & Pozdnyakova, 2025)

III. Results

Morphology: Defining atypical lymphocyte (Downey) cell types

Atypical lymphocytes are defined morphologically as lymphocytes that are enlarged and have a relatively abundant basophilic cytoplasm (which can appear to indent around surrounding red blood cells), open chromatin and rare nucleoli. Classical morphology text books and image libraries depict Downey cells typically in the types II-III as being typical of lymphocytes that have been activated by a virus (Pinto, 2024)

Cellular origin — immunophenotype and clonality (primary studies)

- The work by Pattengale and colleagues in 1974 in the New England Journal of Medicine established that atypical lymphoid cells (AL) represent the immune system's cellular response to a viral pathogen (EBV) and provided the first evidence of the existence of a cellular immune response to EBV infection - consisting primarily of CD4+ and CD8+ T-cells. (Pattengale, Smith, & Perlin, 1974)

In contrast, Callan and coworkers used advanced techniques to demonstrate that CD8+ T-cells were the dominant cell type in AL and were the main cause of the lymphocytosis observed during acute EBV IM. Using flow cytometry and molecular T-cell receptor analysis, the authors concluded that the CD8+ T-cell response to EBV was antigen-specific and resulted from substantial clonal or oligoclonal (monoclonal) expansion during the acute phase of EBV IM. (Callan, Steven, Krausa, Wilson, Moss, Gillespie, Bell, Rickinson & McMichael, 1996)

All of the studies presented show that there is substantial mechanistic support for the fact that the majority of atypical lymphocyte populations consist of activated CD8+ cytotoxic T lymphocytes, which appear to be oligoclonal or monoclonal in nature and are responding to the presence of EBV antigens. (Pattengale, Smith, & Perlin, 1974)

Kinetics - Development and Appearance of Unusual Lymphocyte Peaks

The appearance of atypical lymphocytes generally occur by the end of the first week of symptomatology and peak during the second week of illness, and typically decline over the subsequent weeks although their continued presence during convalescence may still be observed in mild forms. This timeline coincides with the demonstrated proliferation of antigen-specific CD8 T-cells in immunological studies. (Tembhare et al., 2010)

Individual performance on tests for diagnostic threshold (smear, heterophile, serological testing) as follows:

- Cutoff for atypical lymphocytes ≥ 10% Many studies, including articles and reviews, recommend a ≥ 10% cutoff for atypical lymphocytes, which means the traditional clinical diagnostic for determination of EBV infection by smear are ≥ 10% atypical lymphocytes; the clinical literature indicates that the sensitivity of the cutoff for EBV infection in adult populations is reported to range between 70 and 80%. However, the sensitivity of this test in younger versus older age groups and at different stages of the course of the viral infection can vary widely. (Sylvester, Buchanan, & Silva, 2023)
- Heterophile (Monospot) While the heterophile antibody (a.k.a., Monospot) test is relatively inexpensive and provides an immediate result, the clinical literature reviews cite a lower r-squared (54 to 87%) for the heterophile test (typically in the range of 54-87%) and high specificity (90%). In patients that are suspected to have EBV infection but whose heterophile test result is negative should have EBV-specific (VCA IgM) serological testing performed. (Stuempfig & Seroy, 2023)

EBV-specific serology (reference standard) EBV-specific serological testing is the diagnostic reference standard for all EBV infections. Tests such as the VCA IgM test and EBV-specific serological tests with varying patterns of VCA IgG and EBV nuclear antigen (EBNA) are used as confirmatory tests in cases when heterophile test results are negative or uncertain. (Sylvester et al., 2023)

Representative diagnostic-study findings: Current studies show the sensitivity and specificity of the Monospot test have been reported between 87% and 91% sensitivity rate in several studies, while sensitivity varies based on the individual, time of evaluation and the clinical setting (AAFP). Other studies and cohorts from across the United States have evaluated the Monospot test in 2025 and have showed much lower rates of sensitivity (~54% sensitivity for cases where individuals presented early for evaluation) which shows the variability in sensitivity based on the situation. (Sylvester et al., 2023)

Automated analyzer indices (HFLC / HFC) vs manual smear

In addition to the Monospot test, we can measure the number of high-fluorescent lymphocytes (HFLCs or HFCs) via modern hematology analyzers (MHA) which may be equivalent to atypical lymphocyte counts obtained by manually evaluating a peripheral smear through microscopy. Several validation studies are showing that there is a good correlation between the HFLC/HFC and manual atypical lymphocyte (AL) counts, and have suggested cutoffs for using the

HFLC/HFC to identify samples for manual evaluation in the peripheral smear; however, the actual cutoff and diagnostic capability may vary greatly between MHAs and different populations. (Xie, Wu, & Cui, 2018)

IV. Discussion

Discussion of Previous Studies

Infectious mononucleosis caused by Epstein-Barr Virus (EBV) is characterized by atypical lymphocytes (AL); several early research papers described these types of lymphocytes. The first major study on this topic, Atypical lymphocytes in acute infectious mononucleosis (Pattengale et al., 1974), used T- and B-cell surface markers to show that atypical lymphocytes were immunophenotypically T cells, challenging the earlier idea that they were infected B lymphocytes. This finding was crucial because it established that ALs were markers of the host immune response rather than direct virus-induced effects. (Pattengale, Smith, & Perlin, 1974)

Using the immunophenotyping findings from Pattengale et al., another study, Large clonal expansions of CD8+ T cells in Acute Infectious Mononucleosis (Callan et al., 1996), performed molecular and flow cytometric analyses and demonstrated that acute IM is associated with large monoclonal or oligoclonal expansions of CD8+ T cells that are driven by specific EBV antigens. Evidence from this study corroborated the initial theory that ALs are a CD8+ cytotoxic response to EBV-infected B cells. (Callan, Steven, Krausa, Wilson, Moss, Gillespie, Bell, Rickinson, & McMichael, 1996)

Additional research confirmed this cellular immunology-based theory via the study Direct Visualization of Antigen-Specific CD8+ T Cells During the Primary Immunologic Response to Epstein-Barr Virus in Vivo (Callan et al., 1998), wherein CD8+ T cells undergoing proliferation as a consequence of exposure to a specific antigen were directly identified and visualized using MHC–peptide tetramers. (Callan, Tan, Annels, Ogg, Wilson, O'Callaghan, Steven, McMichael, & Rickinson, 1998)

Additional studies compared the immunophenotypic characteristics of the various causes of reactive and atypical lymphocytosis and concluded that while Atypical Lymphocytes can occur in the context of other viral infections (non-EBV) to include immune response/inflammation, the characteristics of Atypical Lymphocytes associated with EBV (particularly the increased percentage of CD8+(particularly CD8+ CD57−) T-lymphocytes as well as increased proportion of γδ-T-lymphocytes) are distinctive^73. With regard to absolute CD4+ and B-cell counts, the proportions of these lymphocytes remain stable during the course of EBV-induced infectious mononucleosis. (Hudnall, Patel, Schwab, & Martinez, 2003)

After decades of advances in immunology, ongoing studies (e.g., 2010) continue to document the presence of Atypical Lymphocytes (Downey cells) in the blood of EBV Infectious Mononucleosis patients; this underscores the fact that morphology will always remain important in the diagnosis of Atypical Lymphocytes. (Tembhare, Ramani, Syed, & Gupta, 2010)

All of the above studies collectively support:

* The definition given to Atypical Lymphocytes by Pattengale in terms of their immunologic characteristics.

The rationale for Atypical Lymphocyte proliferation by Callan, in 1996 and 1998^70.

The comparative immunophenotypic studies of atypical lymphocytes and how they differ between Reactive and Non-Reactive atypical lymphocytes associated with EBV and Non-EBV related reactions.

The validation of the importance of morphology and clinical/professional practice by the continuing studies/sexual evidence showed Atypical Lymphocytes play a very important role in diagnosing infectious mononucleosis today.

The historical and modern-day evidence regarding the significance of Atypical Lymphocytes as a morphological and immunologic marker of the cytotoxic T-cell response to EBV infection is significant and will continue to have implications for how we diagnose EBV infections and provide evidence that Atypical Lymphocytes serve as an important marker for diagnostics of EBV infections.

The Diagnostic Utility of Atypical Lymphocytes with respect to Heterophile Testing and Serological Testing

Atypical lymphocytes are often used to help confirm the diagnosis of infectious mononucleosis in its early stages, since they can present before heterophile antibodies can be detected. This explains why the Monospot test has been reported to have significantly variable sensitivity— as low as 54% in early-stage disease, and generally lower for younger patients. On the contrary, atypical lymphocytes can be detected earlier than heterophile antibodies, and when present and comprising more than or equal to 10% of the total lymphocyte population, these cells exhibit a sensitivity and specificity greater than 90%. EBV-specific serology is still considered the best confirmatory test for most cases of infectious mononucleosis; however, it is usually less accessible and more expensive than a Monospot test. Therefore, atypical lymphocytes provide a rapid, morphology-based indicator that may be particularly helpful in diagnosing voluntary eosinophilic vasculitis in its early stages, or when practitioners cannot access serological tests due to geographic limitations. (Stuempfig & Seroy, 2023)(Centers for Disease Control and Prevention, 2024)

Age-Related Differences in Atypical Lymphocyte Responses

The diagnostic use of atypical lymphocyte responses, based on the patient 's age, shows that younger than age 12 often demonstrate less dramatic atypical lymphocyte responses; however, even in cases of documented EBV infection, atypical lymphocytosis is not seen as pronounced in the younger population. The reduced sensitivity of the Monospot test in younger populations also serves to highlight the importance of serological confirmation when the clinician has a continued clinical suspicion.

In older children, adolescents, and adults, the presence of atypical lymphocytes in the blood is seen in much larger numbers, making the evaluation of these smears much more reliable.

Differential Diagnosis/Overlap of Viral Syndromes

While atypical lymphocytes are characteristic of EBV infectious mononucleosis (IM), other viral syndromes exhibit the same reactive lymphocytosis pattern as EBV IM, such as Cytomegalovirus (CMV) infection, acute HIV seroconversion, viral hepatitis, dengue virus, adenovirus, and some drug hypersensitivity reactions. (Tembhare et al., 2010)

Some of the unique immunophenotypic features of EBV IM, in particular the early dominant expansions of $CD8^+$ cells and γδ-T cells, can be used to distinguish EBV from other similar conditions. (Hudnall et al., 2003)

The Role of Automated HFLC/HFC Tests

Automated HFLC/HFC tests correlate with the detection of atypical lymphocytes and have a role in screening by using hematology analyzers; however, there is variation in performance between different types of analyzers as well as the potential for false positives due to other viral syndromes. (Hudnall et al., 2003)

Clinical decisions regarding the type of treatment should be based upon accurate information, therefore, screening by using automated HFLC/HFC tests should be done only when microscopic confirmation is included with the automated test results.

V. Conclusion

Atypical lymphocytes reflect a person's CD8 T-cell reaction to their body fighting off the Epstein-Barr virus during the initial infection stage and remain an easy-to-access resource when diagnosing infectious mononucleosis. In terms of clinical interaction, along with the use of heterophile testing and EBV-specific serologies (provided they are required), atypical lymphocytes can provide an adequate description of a patient's condition when diagnosing infectious mononucleosis and are especially beneficial in developing countries or as a way to refer patients in resource-constrained areas. Automated analyzer HFLC indices aid in screening but ultimately require local validation and morphology for cases of heterogeneity. (Pattengale et al., 1974)

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PEDAGOGICAL SCIENCES

DEVELOPMENT OF CRITICAL THINKING IN STUDENTS MAJORING IN PHYSICAL CULTURE AND SPORTS IN RUSSIAN LANGUAGE CLASSES THROUGH TEXT

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Abstract

The article discusses the problem of developing critical thinking in students majoring in Physical education and sports based on working with texts in Russian language classes. The study reveals the influence of such activities as reading, analysis, comparison, interpretation, and expression of opinion on students' cognitive activity and the formation of professional thinking skills. The authors suggest ways to improve students' skills in selecting information, arguing, and summarizing using text assignments. The results of the study show that the learning process organized through text allows for the development not only of language competence, but also of reflective and analytical thinking in future specialists. The methodological recommendations presented are aimed at the application of the Russian language in the practice of professional training in universities.

Keywords: critical thinking, working with text, Russian language class, Physical culture and sports major, professionally-oriented training, language competence, analytical skills, higher education.

Introduction

As stated in the address of the president of the Republic of Kazakhstan K. K. Tokayev to the people of Kazakhstan in 2019, one of the main tasks of Kazakhstan's education is the formation of skills that ensure the competitiveness of specialists in the international arena, ahead of modern trends. According to the message, the most important and large – scale task facing the education and science system of the Republic of Kazakhstan is not only to follow new trends, but also to get ahead of them and form trends [1].

To date, the urgent need for the introduction of professionally oriented language training in the system of sports education has been identified. This situation is clearly reflected in the state program for the development of education and science in the Republic of Kazakhstan for 2020-2025 [2].

In this regard, the state mandatory standards of higher and postgraduate education, approved by the order of the minister of Science and higher education of the Republic of Kazakhstan dated July 20, 2022 No. 2, are of particular importance. These standards not only define the requirements for curricula, but also define the tasks for the development of a professionally oriented level of foreign competence [3].

Today, higher education teachers are focused on developing critical thinking skills in their students. In line with this, the introduction of new innovative teaching technologies in the classroom is the main goal of every teacher, as the country needs specialists who can think outside the box, are ready to make urgent decisions, and are capable of thinking actively, creatively, and critically.

Critical thinking plays an important role in the effectiveness of teachers and students. Critical thinking is further creative thinking using cognitive techniques to achieve conceivable results [4, p.15].

The main difference between critical thinking development technology and traditional teaching is that knowledge is not transferred in a ready-made form. Various approaches to critical thinking development technology are completely different from standard teaching methods. In such classes, students majoring in Physical Education and Sports learn to study independently, listen to each other, draw conclusions, and reason. The teacher acts as a coordinator: observing students remotely, analyzing their thoughts without imposing their own opinion, and making corrections where necessary.

Thus, collaborative work brings students and teachers closer together, raises each student's self-esteem, and ensures adequate thinking skills among students majoring in Physical Education and Sports. Critical thinking begins with asking questions and identifying problems that need to be solved. Students ask questions and determine solutions themselves. In the context of modern communication, time shows the need to master all types of speech activities, such as pronunciation, listening, reading, and writing, reading information in Russian, and the ability to convey the information received. This teaching technology, which increases critical thinking and speech activity and is aimed at improving theoretical and creative thinking, will be the beginning of the formation of speech culture skills in students.

From a pedagogical point of view, critical thinking can be viewed as a process of active, creative cognition. With the help of this technology, teachers can develop a system of effective strategies and methods that allow the audience to work together with students to find ways to solve a given problem and create a favorable atmosphere. The basis of critical thinking development technology is a basic model consisting of three stages: “reflection – comprehension – reflection.” This ap-

proach to the educational process helps students independently determine their goals for acquiring knowledge, actively seek new information, analyze the information they receive, and supplement their knowledge. At the reflection stage, students demonstrate their existing knowledge and express their understanding of the given task.

Organizing work at this stage allows students to develop their cognitive interests and determine the purpose of studying a given topic. At the comprehension stage (understanding the essence of the subject), students work with new information, systematize it, and learn to ask questions about new and old information. The reflection phase (reflection, reflection) allows students to consolidate new knowledge and change their initial perception of the new material. In this way, it is possible to acquire new knowledge, comprehend it, and form an individual approach to the material covered. In the course of working with this technology, students master various ways of working with information, learn to make judgments, reason, form their own point of view, argue it with logical arguments, clearly express their thoughts, listen carefully to their opponent's words, etc.

Methods and materials

Memorization and recall when working with text If you ask teachers and students why text work is used in the learning process, you can assume in advance that they will answer that it is for familiarization with new information and comprehensive assimilation of the material. Here, D. Kluster states, "Information is the starting point for critical thinking, not the result of it... As the saying goes, “you can't think with an empty head.” In order to construct complex ideas, you need “raw materials” – facts, ideas, texts, theories, data, understanding" [5, 6].

These facts, ideas, and theories should be learned and understood by students at the initial stage, and they should be able to explain the content of the text. Students not only read the text, but also work together to assimilate the content of the text in their separate groups. This approach to reading is based on the principle of interdependent and independent responsible collective learning. Team members feel a need for each other and a personal responsibility for the outcome of their understanding of the text. This, in turn, is important for accumulating fragments of the text, that is, for assembling each piece of the mosaic, as if the reeds formed a patchwork quilt. The “mosaic” method also allows students to master voluminous material. The role of the teacher also changes during the lesson. They will have to give up the role of “genius on stage” and instead perform functions such as support, counseling, and observation [7, pp. 19-21].

1. The effectiveness of this method also lies in the fact that no student will be left outside the classroom; the learner's language skills will develop as they understand the text they have read, retell it in an understandable form, act it out, and express their opinion. Thus, with the help of organized classes, it is possible to develop literate readers. The “stop-reading with delay” method. Organizing reading with the help of various questions is the conditional name of this methodological approach.

2. Preparatory work:

1. The teacher selects a text for reading. The text is selected based on the following criteria: - the text must be completely unfamiliar to the audience (if the text is familiar, the meaning of using this approach is lost); - the text must consist of a storyline; - the text must end unexpectedly, with an open ending.

2. The text is divided into meaningful parts in advance. The text indicates where pauses should be made, and the “first pause,” “second pause,” etc. are highlighted.

3. The teacher thinks through questions and assignments in advance that are aimed at developing students' critical thinking skills. The teacher explains and organizes the process of reading the text with a delay, ensuring that the rules for working with the text are strictly followed. The types of questions aimed at developing critical thinking should be as follows: - “substitute” and interpret (transform in a new way, replace information, and identify relationships between events, data, and ideas); - memorize - know and reason about the information received; - evaluate - express a personal subjective attitude to the information received, giving your opinion and judgment - generalize - make logical conclusions about the information received, accept cause-and-effect relationships; - analyze – consider what has happened as a fragment, divide the “general” context into “specific” ones; - use – be able to use the information received to solve problems that you encounter in real life.

Scope of application: when teaching excerpts from fiction, when studying the works of poets and writers. Note: delayed learning can be purposefully used at the stages of thinking and reflection in critical thinking technology, supplementing this method with other methods at the stage of comprehension.

Results and discussions

Texts are used to organize experimental work in order to prove the effectiveness of the types and methods of work used in the development of students' language skills.

The aim of the experiment is to identify the most effective methods and techniques for developing students' communication skills through texts. Depending on the results of the decisive stage, the types of work and tasks for developing speech through texts were determined.

The goal of the educational experiment: to develop students' speech by performing oral and written exercises related to texts on various topics. The groups in which we conducted the practice are based on the development of students' speech through tasks and texts that are given at all stages of Russian language classes. All language tasks will be aimed at student communication. The following types of work are used in connection with language development through texts. 1. Language development using language exercises in the text; 2. Language development by practicing the use of opinion exchange in texts; 3. Linguistics using the text; 4. developing students' Russian speech using texts,

composing works, and addressing problematic situations.

To determine the extent to which students' knowledge of physical education improved through speech development using texts, the system of tasks in the control practice and most of the tasks from the determination practice were obtained in the same way. The following tasks related to the above types of work and including these types of work were proposed. 1. Tasks for language development using language exercises: a) find the semantic end of the text; b) by selecting one or two words in the texts, these words can be compared with the tasks performed during the control practice, before and after the learning experience.

Table-1

An indicator of the increase in the level of appropriate text structure usage.

Group	Number of students	Task sequence	At the beginning of the term	At the end of the term	Increase %
Experimental group Control group	21 21	1st task	3 3	14 8	64,72% 29,40%
Experimental group Control group	21 21	2nd task	4 9	13 8	52,0% 23,51%
Experimental group Control group	21 21	3rd task	4 4	14 9	58,62% 29,41%

Table 1 shows that as a result of the training experience, the level of adequate use of text structure by students has increased. 1. The most basic speech exercise in communication is the exchange of opinions. Therefore, instructions were given regarding the use of texts in exchanges of opinion: a) to answer questions briefly in exchanges of opinion; b) to give comprehensive answers to questions; c) supplement exchanges of opinions with questions; d) affirm the content of statements in an exchange of opinions or express the opposite opinion; e) continue the end of an exchange of opinions; f) create an exchange of opinions based on a model, quoting statements and using text on a specific topic.

Group	Number of students	Short answers to questions		Detailed answers to questions		Creating an exchange of opinions based on a model with citations of statements	
1	2	3	4	5	6	7	8
		At the beginning of the term	At the end of the term	At the beginning of the term	At the end of the term	At the beginning of the term	At the end of the term
Experimental group Control group	21 21	5 5	15 8	4 4	12 6	3 3	11 5
In %		29,2 29,2	88,2 46	23,2 23,2	70,58 35,2	17,6 17,6	64,7 29,41

Table 2 Students can understand the meaning of the text and see the increase in the degree of its use among like-minded people in this table. 2. Mastering the text is of great importance in speech training. Language development work using text: a) analyze the meaning of the text and explain it to the student in your own words; b) work on memorizing texts in class aloud and internally, i.e., through repetition; c) practice using the content of the text independently; d) compose your own text.

Group	Number of students	Task sequence	Correctly completed the task		Incorrectly completed task		In %
		At the beginning of the term	At the end of the term	At the beginning of the term	At the beginning of the term	At the end of the term	
1	2	3	4	5	6	7	8
Experimental group	25	1st task	3	13	14	4	58,82
Control group	25		3	6	14	11	17,6
Experimental group	25	2nd task	4	14	13	3	58,82
Control group	25		4	8	13	9	23,52
Experimental group	25	3rd task	2	9	15	8	41,18
Control group	25		2	5	15	12	17,64
Experimental group	25	4th task	2	10	15	7	47
Control group	25		2	5	15	12	17,64

Table 3 shows the results of using active words in the text. In language development, work and presentation are interrelated with oral storytelling. We have tried to include elements of all this in speech development through text. In this regard, the following types of work have been developed: a) answering a given question; b) a brief narrative based on the text; c) a narrative based on a constructed plan; d) retelling the text using key words; e) retelling the text.

Group	Number of students	Answer to the question asked		A brief summary of the text		Narrative according to plan		Retelling a text using keywords		Retelling of the text	
		At the beginning of the term	At the end of the term	At the beginning of the term	At the end of the term	At the beginning of the term	At the end of the term	At the beginning of the term	At the end of the term	At the beginning of the term	At the end of the term
Experimental group	25	5	2	3	10	5	14	6	14	2	8
Control group	25	4	7	7	5	5	8	6	9	2	3
Experimental group	25	29,4	70,5	17,6	58,8	29,4	82,3	35,2	82,3	11,7	47
Control group	25	23,5	41,2	17,6	29,4	29,4	47,5	35,2	52,9	11,7	17,6

Table 4 shows the results of the assigned task. To check the extent to which students majoring in Physical Education and Sports have mastered the tasks and grammatical patterns related to development through texts, the most common types of tests are used. It is known that there are several types of tests. A verification test is used in control practice. The verification test contains the following tasks: a) indicate which topic the provided texts correspond to; b) underline texts on a specific topic; The following issues are taken into account when compiling test tasks: - the same requirements are imposed on students; - control tasks and control tests are checked and answers are discussed.

Group	Number of students	«5»	«4»	«3»	«2»	«1»	In %
Experimental group	25	5	6	6	-	-	64,7%
Control group	25	1	4	6	4	2	29,41%

The tasks in the control test table - 5 are assessed on a five-point scale during the learning process. The text system is not specialized or thematic; it is related to all oral and written tasks in language learning, language development, and language topics. The communicative competence of learners is determined by the use of the following indicators in the text. 1. The number of active words you know; 2. The correct use of active words. The result of these indicators was as follows (see diagrams 1 and 2).

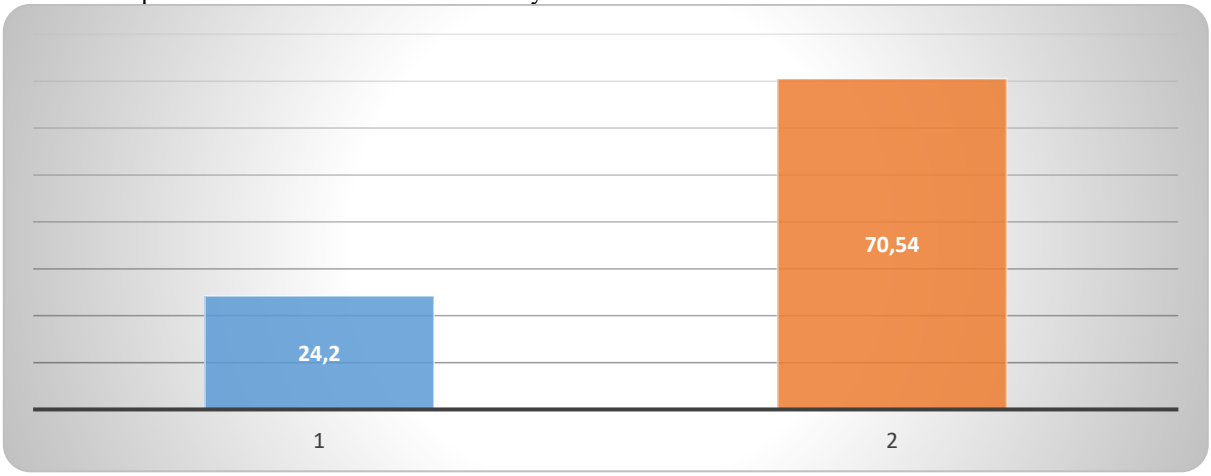

Figure 1. Indicator of students' use of active words after reading the text.

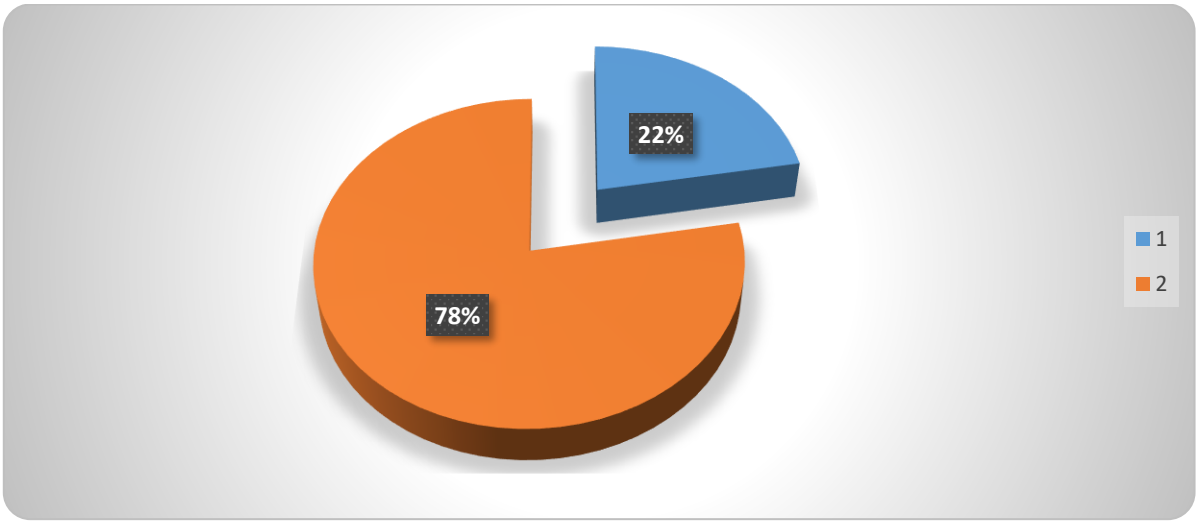

Figure 2. Indicator of exercise usage by students.

As we have seen in the tables above, the levels of indicators have undergone significant changes.

Types of tasks		Levels of knowledge of students in the group in which the experiment is conducted, in percentages		Knowledge levels of students in the control group%	
1	2	3	4	5	6
		EG	CG	EG	CG
1	Explain the meaning of active words and find the Russian equivalent. a) Those who completed the task completely and correctly b) Those who partially completed the task c) Those who completed the task incorrectly	 76,5% 23,5% -	 75% 25% -	 47% 29,4% 3,5%	 43,75% 31,25% 25%
2	Explanation of the content of these active words a) those who completed the task completely and correctly b) those who partially completed the task c) those who completed the task incorrectly	 64,7% 35,3% -	 68,75% 31,25% -	 41,2% 29,4% 29,4%	 50% 25% 25%
3	Completing tasks related to finding the end of a text a) those who completed the task completely and correctly b) those who partially completed the task c) those who completed the task incorrectly	 70,6% 23,5% 5,9%	 75% 25% -	 23,6% 25,9% 35,3%	 31,25% 37,5% 31,25%
4	Completion of tasks related to searching for text depending on the spoken word: a) those who completed the task completely and correctly b) those who partially completed the task c) those who completed the task incorrectly	 47,5% 35,6% 17,64%	 43,75% 37,5% 18,75%	 17,64% 29,41% 52,9%	 18,75% 31,25% 50%
5	Explaining the text and composing sentences using their participation a) those who completed the task completely and correctly b) those who partially completed the task c) those who completed the task incorrectly	 7,6% 23,6% 5,9%	 68,75% 25% 6,25%	 35,3% 35,3% 29,4%	 37,5% 31,25% 37,5%

Table-6 The results of comparing the degree of students' understanding of texts in control practice can be seen in Table Tasks set with the aim of developing creativity through texts were organized on the basis of the following principles:

1. Activities promoting interaction with tasks are covered;

2. Repetition of active words in the text was monitored/practiced/in the text/in like-minded people/written works/;

3. Ensured mutual continuity of topics of the text and lexical topics;

4. Selected texts that are convenient for students to learn and used in everyday life;

5. The texts were chosen taking into account their educational significance.

Conclusions

Thus, the texts consolidated the spoken language using the methodological approaches used and the effectively presented theoretical data gave good results in teaching the Russian language. Analysis of the results of the experiment, during which the use of text content in the language developed. The organization based on interaction in the language environment caused high motivational interest and activity of students; in the course of working with various problem exercises and tasks, the student's thinking, speech, and communication activities developed. As a result of building on the basis of subject-subject relations during participation, the student realized himself as a subject and realized responsibility for the productivity of understanding the text, as well as through reflective activities organized

after each classroom lesson in the specialty “Physical culture and sports” analysis, assessment and identification of shortcomings and achievements of students in their educational activities as a result of which they have enthusiasm and a desire to eliminate their shortcomings and achieve new achievements.

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PSYCHOLOGICAL SCIENCES

PSYCHOLOGICAL CHARACTERISTICS OF THE ADOLESCENT PERIOD

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Abstract

One of the serious changes that occur in adolescents is the changes in their emotional sphere. The volatility of emotions and feelings makes them difficult to control and leads to the weakening of the adolescent's self-reflection and self-control. The constant and intense manifestation of feelings is also characteristic of the adolescent age period. In general, the feelings of the adolescent are almost always contradictory. Any minor injustice upsets them, and the adolescent shows a behavior that does not take into account the final result. Therefore, when influencing the adolescent's personality, the strong influence of feelings and emotions on behavior should be taken into account. Because feelings help resolve psychological conflict by giving priority to one of the competing demands. Of course, only optimal emotional tension prevents a sober and correct analysis of the situation and results in mistakes. In addition, negative emotional states are also dangerous for mental health. Therefore, teachers and educators should refer to positive feelings and emotions when influencing the adolescent's personality. In this case, the teenager believes in the importance of "reconstruction", the necessity of "changing oneself" is perceived not as "renunciation of oneself", but as a move towards the desired goal. He tries to find his place in the collective, to establish a business and emotional connection with it. The teenager tries to be guided by his desires from the position of "necessity", which helps to resolve the psychological conflict, "reconstruct oneself", saves him from being influenced by his own demands, creates clarity of inner thought. There are also contradictions that are characteristic only of adolescence.

Keywords: physical changes, conflict, emotional connection, teenager.

During this transitional period, complex physical changes occur, which seriously affect the psychology of the teenager. Already more or less acquired life experience and existing knowledge allow him to move to a new level of behavior. The teenager, first of all, begins to perceive himself as a person. A sense of personal dignity manifests itself in a particularly pronounced form. He does not tolerate the approach to him with the dimensions of childhood, step-by-step guardianship. Excessive parental care, or unnecessary control and attempts to lead at every step, restrictions (if there are children aged 6-10 in the family) oppress the teenager even more.

Physical and mental development, new and higher requirements for the teenager at school and in the family create the basis for the development of an extremely important character trait in him - the teenager is already beginning to defend his right to independence, he tries to be like adults and wants others to feel that he has grown up, to reckon with him. At all ages, children want to seem grown-up, but if by adolescence this manifests itself in the form of a "big game", then the teenager often has the opportunity to behave like an adult and therefore seriously wants to be an adult.

The teenager is no longer an unspoken executor of the requirements of parents and teachers, like a younger schoolchild. He has his own opinion about life events, people, their behavior.

In general, the role of will in resolving both external and internal contradictions is great, and by regularly developing will, a teenager can regulate his behavior and relationships.

Contradictions are resolved in the process of activity, in communication with other people, especially with the collective. In the process of communication, a teenager understands that social connections and the actions conditioned by them directly or indirectly affect his successes or failures. Only in communication with the collective does a teenager understand the meaning of his behavior for himself and for those around him. Therefore, it is extremely necessary to prepare a teenager to “study” his activities, to learn the attitude of others to him, to “see” his own advantages and disadvantages.

Taking into account the role of observation and self-observation in understanding the meaning and causes of mental conflict, it is necessary to direct the teenager to this, to form in him the ability to compare his observations with the observations of his peers, teachers and parents. This helps the teenager to understand the dependence of his “I” on social norms and rules and the importance of mastering them.

When studying the history of the study of Internet addiction in psychology, we determined that the mentioned problem was studied in different directions. In psychology, Internet use and extreme deviations during use, and ultimately the manifestation of Internet addiction, were evaluated as a current problem and were studied in different directions. The studies conducted in this area can be mainly grouped into the following directions:

1. Studies conducted in foreign psychology (America);
2. Studies of psychologists of a near foreign country, more precisely, Turkish;
3. Studies of Azerbaijani psychologists.

When studying the theoretical and historical issues of the study, we initially looked at the studies of American psychologists.

To this day, Internet addiction and its Many studies have been conducted on the effects of the Internet. In 1999, David Greenfield, director of the Center for Internet Behavior, conducted a study with ABC news.com and concluded that the services offered by the Internet increase the risk of users being exposed to disorders such as dissociation of identity, improper use of time, loss of reality, and instant gratification, and such situations are manifested in the daily lives of 6% of all Internet users. The Internet is an important tool that helps individuals to easily connect with each other, quickly establish relationships with other people without distance, and is a source of knowledge. Video conferences with people on the other side of the world via e-mail, obtaining knowledge from world libraries, instantly being informed about what is happening in the world, listening to music or watching movies, playing games, shopping without borders and without effort, and conducting financial transactions even from home - these are just a few of the countless things that the Internet has added to the lives of individuals[6;12].

However, when Internet use takes up most of an individual's time, the problem of Internet addiction has emerged. Internet addiction is manifested by symptoms such as not setting limits on Internet use, continuing to use it despite social or academic harms, and feeling deprived when the Internet is not available (N.A.Shapira, M.C.Lessig,T.D. Goldsmith, S.T.Szabo, M. Lazoritz, M.S.Gold, D.J.Stein, 2003)[6].

The vast majority of studies on Internet addiction in the psychological literature have been conducted with university students and adults. (I.J. Bakken, H.G.Wenzel, K.G.Götestam, A. Johansson, A.Oren, 2009; G. Ferraro, B. Caci, A.D'Amico, M. Blasi, 2007; L. Leung, 2004)[2].

However, due to the gradual increase in the number of adolescents as Internet users (K. Subrahmanyan, G. Lin, 2007)[7], various studies have been conducted in the last decade to investigate the facts about Internet addiction in adolescents (DiNicola, 2004; K.S. Jang, S.Y. Hwang, J.Y. Choi, 2008; K. Kim, E. Ryu, M-Y. Chon, E-J. Yeun, S-Y. Choi, J-S. Seo, B-W. Nam, 2006)[8].

While the Internet is emerging as a resource that facilitates adolescents' access to knowledge, research, and investigation, and at the same time develops skills such as problem-solving and critical thinking (I.Berson, M.Berson M, 2003)[5], on the other hand, it is also thought that it negatively affects personal skills due to excessive, aimless, and uncontrolled use. (J.Colwell, M.Kato, 2003; C.J.Kerber, 2005)[4].

Internet addiction is an addiction that can manifest at any age. However, adolescents are one of the most important risk groups here (Ö.Öztürk, G. Odabaşıoğlu, D. Eraslan, Y. Genç, Ö.A.Kalyoncu, 2007)[8]. The intense interest of adolescents in technology leads them to use the Internet more than other age groups (T.Treuer, Z. Fabian, J. Füredi, 2001; L.Widyanto, M.McMurran, 2004) [1].

Adolescence is a period when adolescents are at the center of cognitive, emotional and social development, which makes individuals a potential risk group for Internet addiction (A.A.Ceyhan, 2008; C.Tsai, S.J.Lin, 2001; S.C Yang, C.J. Tung, 2007) [4].

C.Chou and M.C. In a study conducted by Hsiao in 2000 [6], it is noted that the increase in Internet use among adolescents reduces the time allocated for real social relationships and face-to-face meetings, causes social isolation, and it is observed that the loneliness of adolescents who use the Internet excessively increases.

American psychologists Y.A. Hamburger and E. Ben-Artzi revealed an interesting fact as a result of the studies conducted in 2003: it was proven that Internet addiction does not cause loneliness, but Internet addiction occurs as a result of loneliness.

X. Chen, F. Li, L.L.Long proved in their studies conducted in 2007 [5] that the observation of Internet addiction is high in schoolchildren with a low level of social support and that low social support is a risk factor for Internet addiction. When examining the theoretical and historical issues of the study, we initially looked at the studies of American psychologists, but at the same time, extensive research by Turkish psychologists in this field is also known to science. When we review the studies conducted by Turkish psychologists, we observed that studies on internet addiction started in the 2000s. Among these researchers, clinical psychologist Feyza Bayraktar (2001) investigated the impact of internet use in adolescence on the mental and social development of adolescents[8]. N.S.Ayaroğlu (2002) studied the relationship between internet use and loneliness among university students[2].

While investigating the study of internet addiction, it was found that adolescents (G.T.Kurtaran, 2003; A.Y.Tahiroğlu, G.G.Çelik, M.Uzel, N.Özcan, A.Avcı, 2008)[4] and university Studies that have studied the purposes of Internet use of university students (A.A. Ceyhan, 2008)[6], and in some cases, primary school students (A. Ersoy, Sh. Yaşar, 2003; F. Orhan, B. Akkoyunlu, 2004 attract attention.

While examining the studies that have studied Internet addiction in Azerbaijani psychology, we identified a dissertation by Gudsi Faranak Bahaddin entitled "Comparative social-psychological analysis of the behavior of schoolchildren using the Internet". The dissertation covered schoolchildren from Tehran and Baku (Gudsi Faranak Bahaddin, 2016). In the dissertation work, the socio-psychological issues of Internet addiction in schoolchildren in the modern era were investigated, the factors affecting the development of Internet addiction were systematized, and the psychological problems caused by Internet addiction on different ethnic grounds were analyzed based on a comparative social-psychological analysis. At the same time, the dissertation put forward theoretical and practical considerations for the effective use of technologies by schoolchildren and the preservation of their socio-psychological health, clarified the problems caused by Internet addiction in schoolchildren's behavior, determined the levels of the relationship between Internet addiction and social activity, and found a significant relationship between Internet addiction and suffering, depression, and physical health of school Internet users. It was determined that when Internet addiction is high,

depression increases, suffering increases, and health status weakens[2].

In general, when examining studies that have studied Internet addiction in Azerbaijani psychology, we determined that there are some articles, theses, and conference reports in this field. However, we did not come across a broad, fully and in detail experimental study that would explain the problem.

While working on the history of the study, one fact also attracted our attention: it is observed that there is a limited number of studies aimed at studying the symptoms that increase or cause Internet addiction, and these studies have come to the fore in the last 2-3 years. In this regard, there is a great need for studies that will study the factors that create Internet addiction. That is why we chose the problem of Internet addiction as the subject of research. In the research conducted by us, the age-sex determinants of Internet addiction in adolescents are determined, and the lifestyle indicators of adolescents with Internet addiction are reviewed. At the same time, the relationship between Internet addiction and depression and causeless anxiety is considered, and the level of depression and anxiety of adolescents with Internet addiction is determined. In this section, we reviewed the theoretical and historical issues of Internet addiction, or rather, the history of research on the problem by foreign psychologists, as well as psychologists from a near foreign country, namely Turkish psychologists, and finally, the history of research on the subject in Azerbaijan.

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TECHNICAL SCIENCES

MATHEMATICAL MODELING OF INERTIAL DISTURBANCE PROPAGATION ON A VEHICLE BASE UNDER INDIRECT LINEAR MOTION

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Abstract

The physical picture of the disturbances affecting the main armament of the vehicle in the horizontal and vertical guidance channels under conditions of curved linear uneven movement is considered and an analysis is given. External inertial disturbances affecting the vehicle armament in the horizontal guidance channel are determined by the action of centrifugal forces arising when the vehicle turns and the action of inertial forces accelerating or decelerating the vehicle, as well as the current value of the angle of rotation of the turret relative to the hull.

The continuous increase in the power of the powertrain systems of domestic and foreign vehicles, and therefore their mobility and maneuverability, has led to a significant increase in external disturbances caused by inertial forces acting on the main armament and arising from the uneven movement of the vehicle along the curved line.

To ensure the reliability of the results of the assessment of functional and resource characteristics and optimization of design parameters and operating factors, the most important requirement for mathematical models is the description of the processes and phenomena under consideration with the approximation of the calculated values to the experimental data necessary for engineering calculations. Most of the mathematical models of the movement of wheeled vehicles known from the scientific and technical literature describe their rectilinear movement. Mathematical models of the curvilinear movement of wheeled vehicles, as a rule, are compiled using Lagrange equations of the 2nd kind and describe steady circular motion.

To increase the accuracy of stabilization of the boresight axis of a machine gun relative to the direction towards the target, it is advisable to use an invariant stabilizer instead of a traditional PD stabilizer in both horizontal and vertical guidance channels.

Keywords: car gun, inertial external disturbances, uneven curved motion.

1. INTRODUCTION

Problem statement

The continuous increase in the power of the propulsion systems of domestic and foreign tanks and, as a result, an increase in their mobility and maneuverability indicators has led to a significant increase in external disturbances caused by inertial forces acting on the main armament and arising during the uneven movement of the vehicle in a curved direction. These forces include centrifugal forces when turning the vehicle and inertial forces when changing speed - acceleration or deceleration.

Formulation of the research objective

The purpose of this article is to develop a method for calculating external inertial disturbances affecting the vehicle gun during uneven curvilinear motion of a tank.

2. RESEARCH METHODOLOGY

Consider a tank turret with a gun shown in Fig. 1, in horizontal projection at different positions of the turret relative to the vehicle body [1]. 1a corresponds to the case when the longitudinal axes of inertia of the hull and turret coincide in direction, and Fig. 2. 1b corresponds to the case when the turret's own longitudinal axis of inertia rotates with respect to the vehicle's own longitudinal axis by an angle ψ0 = π/2 [3]. In the first case, the vehicle rotates with the current radius

$$R(t) = \frac{v(t)}{\psi_k(t)} \qquad (1)$$

where v (t) is the current velocity of the center of mass; ψk (t) - c Fy(t) is the angular velocity of rotation of the body caused by the centrifugal force applied to the center of mass of the gun and turret 0c [4]. This force is determined by the dependence

$$F_y(t) = -m_\delta a_y(t) = -\frac{m_\delta v^2(t)}{R(t)} = -m_\delta v(t)\dot{\psi}_k(t) \qquad (2)$$

where mb is the mass of the turret with the gun and is the cause of the deviation of the barrel axis of the car gun from the target direction in the horizontal guidance plane.

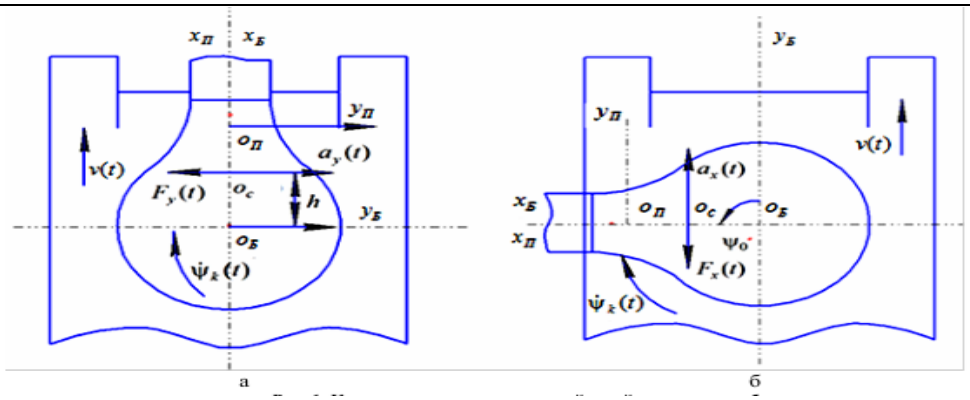

Fig. 1. Finding external influences on the car tower.

In the second case, shown in Fig. 1b and corresponding to ψ0 = π/2, the centrifugal force Fy(t) is applied along the longitudinal axis of the tower and does not cause it to rotate relative to the axis of rotation [5]. In this case, the disturbing effect on the tower is exerted by the inertial force Fx(t) resulting from the accelerated (decelerated) motion of the vehicle body and

$$(3)F_x(t) = -m_\delta a_y(t) = -m_\delta \dot{x}(t)$$

where ax(t) is the linear acceleration (deceleration) of the car body; x(t) is the current linear displacement of the object [6].

If the condition is met

$$0 \le \psi_0(t) \le \frac{\pi}{2}$$

is determined by the ratio of the total disturbing moment acting on the car tower

$$(4)M_\psi(t) = h\left[F_y(t)cos\psi_0(t) + F_y(t)sin\psi_0(t)\right] = -m_t h[\vartheta(t)\psi_k(t)cos\psi_0(t) + x(t)sin\psi_0(t)]$$

where h is the lever of application of the disturbing force, which is equal to the distance between the center of gravity of the tower and the center of rotation.

When ψ0 = 0, relation (4) becomes formula (2), and when ψ0 = π/2, it becomes formula (3).

We will consider the car cannon as a two-mass system, schematically shown in Fig. 1. 2. The diagram shows the masses mc and mk connected to each other by a rigid rod hinged at point oc, where the mass mc is equal to the mass of the car cannon barrel, and the mass mk is equal to the mass of the tank cannon barrel, the angle corresponds to the current elevation angle of the gun, the distance from the axis of the centers of gravity of the barrel and the breech, respectively [6].

Consider the diagram of a car ball, corresponding to the state ψ0(t) = 0 in a vertical plane passing through the longitudinal axis of the car body and shown in Fig. 2a. The accelerated (decelerated) motion of the car with acceleration x(t) gives rise to inertial forces F1x(t) and F2x(t) [7]. The resultant external forces acting on the masses are mc and mk

$$F_{1\varphi}(t) = F_{1x}(t)sin\varphi_0(t) - Cccos\varphi_0(t) \quad (5)$$

$$(6)\ F_{2\varphi}(t) = F_{2x}(t)\sin\varphi_0(t) - G_k\cos\varphi_0(t)$$

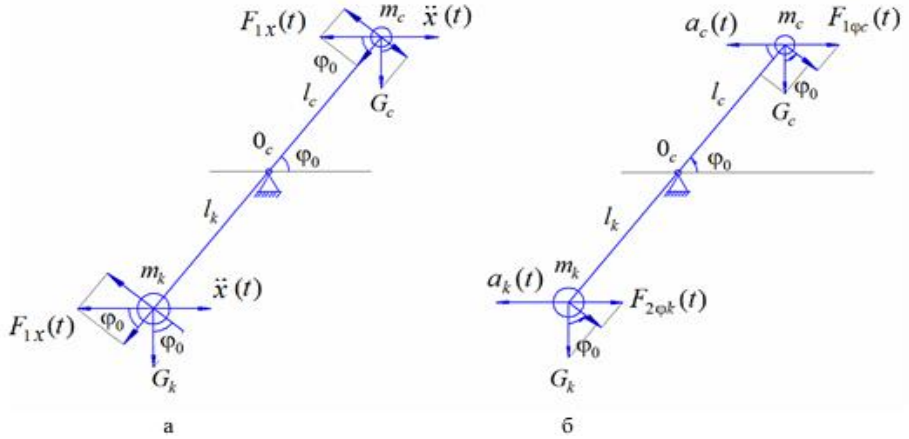

Fig. 2. Finding external influences on the car weapon

The moments of the external forces (5) and (6) are directed towards each other [8]. The total moment acting on the weapon is determined by the ratio

$$M_\varphi(t) = 1_cF_{1\varphi}(t) = 1_kF_{2\varphi}(t) = 1_cF_{1x}(t)sin\varphi_0(t) - G_c\cos\varphi_0(t) - 1_kF_{2x}(t)\sin\varphi_0(t) - G_c\cos\varphi_0(t) = -1_cm_cx(t)sin\varphi_0(t) - 1_cG_c\cos\varphi_0(t) +$$

$$-1_km_kx(t)\sin\varphi_0(t) + 1_kG_k\cos\varphi_0(t) = x(t)\sin\varphi_0(t)[1_km_k - 1_cm_c] + g\cos\varphi_0(t) = [1_km_k - 1_cm_c] \quad (7)$$

The car gun is balanced relative to the axis of the couplings [9]. The equilibrium condition can be written as

$$G_c1_c = G_k1_k$$

or

$$m_c1_c = m_k1_k \quad (8)$$

Taking into account equation (8), relation (7) is written as

$$M_{\varphi}(t) = 0 \quad (9)$$

Thus, the accelerated (decelerated) movement of the vehicle does not disrupt the balance of the vehicle's weapon and does not create disturbing moments that cause the weapon's position to change relative to the axis of the tires [10].

3. DISCUSSION OF RESULTS

Let us consider the effect of centrifugal forces on the vehicle gun when the tank rotates with angular velocity (tk ψk (t). Let us denote the linear velocities of the points mc and mk as vc and vk, respectively, and denote the radius of rotation R and the radius of rotation of the trunnion points as.

$$v_c(t) = \psi_k(t)[R + I_c cos\varphi_0(t)] \quad (10)$$

$$v_k(t) = \psi_k(t)[R + I_k cos\varphi_0(t)] \quad (11)$$

The centrifugal forces acting on the masses mc and mk are determined by the relations:

$$F_{1\varphi c}(t) = m_c\psi_k^2(t)[R + I_c \cos\varphi_0(t)] \quad (12)$$

$$F_{2\varphi c}(t) = m_k\psi_k^2(t)[R + I_k \cos\varphi_0(t)] \quad (13)$$

The total moment due to the action of the moments created by the centrifugal forces (12) and (13) is

$$M_{\varphi}(t) = I_k F_{2\varphi k}(t) sin\psi_0(t) - I_c F_{1\varphi k}(t) in\psi_0(t)$$
$$= -\psi_k^2(t) sin\psi_0(t)$$
$$\cdot m_c[R + I_c \cos\varphi_0(t)]I_c \sin\varphi_0(t)$$
$$- m_k[R - I_k \cos\varphi_0(t)]I_k \sin\varphi_0(t)$$
$$= \psi_k^2(t)\sin\psi_0(t)(m_c I_c$$
$$- m_k I_k)R \sin\varphi_0(t) + m_c I_c^2 \cos\varphi_0(t)\sin\varphi_0(t)$$
$$+ m_k I_k^2 \cos\varphi_0(t)\sin\varphi_0(t) \quad (14)$$

Taking into account the equilibrium condition (8), the relation (14) takes the final form

$$M_{\psi}(t) = -\psi_k^2(t)\sin\psi_0(t)(m_c I_c^2 + m_k 1_k^2)\cos\varphi_0(t)\sin\varphi_0(t) \quad (15)$$

Thus, relations (4) and (15) determine the moments of inertia of external disturbances acting on the turret and gun of the vehicle during the uneven movement of the vehicle in a curved direction. In modern vehicles, the mass of the turret with a gun in the turret is about a third of the total mass of the vehicle, so the moment of inertia (4) can reach significant values [11]. To increase the accuracy of stabilization of the barrel axis of a vehicle gun in the horizontal guidance channel of Ukrainian ZIL-131, T-80UD and T-84 vehicles, instead of the traditional PD stabilizer, an invariant stabilizer is used, which includes a gyroscopic angle and angular velocity sensor with a relative velocity sensor].

Analysis of the relation (15) shows that for small values of the angles ψ0(t) and ϕ0(t) the magnitude of the disturbing moment Mϕ(t) is small. At the same time, when conducting combat operations in mountainous terrain with significant values of the angles ψ0(t) and ϕ0(t), the moment (15) reaches high values, which leads to the conclusion about the expediency of using an invariant stabilizer in the vertical guidance channel of the vehicle gun [2].

4. CONCLUSION

External inertial disturbances acting on the turret of a vehicle with a gun in a horizontal guidance channel are determined by the influence of centrifugal forces arising when the vehicle turns and the influence of inertial forces during acceleration or deceleration of the vehicle, as well as the current value of the turret rotation angle relative to the hull.

External inertial disturbances acting on the vehicle's gun in the vertical guidance channel do not depend on the acceleration or deceleration of the vehicle body but are determined by the angular velocity of the body rotation and the current value of the turret rotation angle relative to the body and the gun elevation angle.

To increase the accuracy of stabilization of the barrel axis of a machine gun relative to the direction towards the target, it is advisable to use an invariant stabilizer instead of a traditional PD stabilizer in both horizontal and vertical guidance channels.

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НАУКОВІ ЗАСАДИ УЗГОДЖЕННЯ ОРГАНІЗАЦІЙНО-ТЕХНОЛОГІЧНИХ І ІНФОРМАЦІЙНО-УПРАВЛІНСЬКИХ РІШЕНЬ У СИСТЕМІ РЕАЛІЗАЦІЇ ТА ВІДНОВЛЕННЯ БУДІВЕЛЬНИХ ПРОЄКТІВ

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SCIENTIFIC FOUNDATIONS FOR THE COORDINATION OF ORGANIZATIONAL-TECHNOLOGICAL AND INFORMATION-MANAGEMENT DECISIONS IN THE SYSTEM OF IMPLEMENTATION AND RECOVERY OF CONSTRUCTION PROJECTS

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Анотація

Реалізація та відновлення будівельних проєктів відбуваються в умовах зростаючої організаційно-технологічної складності, ресурсних обмежень і високої динаміки зовнішнього середовища, що зумовлює підвищені вимоги до узгодженості управлінських рішень. За таких умов будівельний проєкт доцільно розглядати як складну адаптивну систему, у межах якої організаційно-технологічні та інформаційно-управлінські рішення формують єдиний керований контур.

Обґрунтовано, що ефективність реалізації та особливо відновлення проєктів визначається не локальною оптимальністю окремих рішень, а рівнем їх системної узгодженості та здатністю управління адаптуватися до змінного стану проєктного середовища. Запропоновано інтегральний показник стану проєктної системи, коефіцієнт узгодженості рішень та індекс адаптивності управління, які забезпечують кількісну оцінку керованості, результативності та стійкості будівельних проєктів.

Розроблено рекурентну модель трансформації інформаційно-управлінських рішень у часі та інтегральний критерій ефективності управління в умовах відновлення. Використання структурно-динамічних схем і дашбордних моделей дозволяє забезпечити практичну реалізацію інтегрованого підходу до управління будівельними проєктами. Сформульовані положення створюють методичну основу для впровадження адаптивних систем управління, орієнтованих на підвищення стійкості та керованості процесів реалізації й відновлення.

Abstract

The implementation and recovery of construction projects take place under conditions of increasing organizational and technological complexity, resource constraints, and high environmental dynamics, which significantly intensifies the requirements for the coordination of managerial decisions. Under such conditions, a construction project should be considered as a complex adaptive system in which organizational-technological and information-management decisions form a unified control loop.

It is substantiated that the efficiency of project implementation and especially recovery is determined not by the local optimality of individual decisions, but by the level of their systemic coordination and the ability of management to adapt to changes in the project environment. An integral indicator of the project system state, a decision coordination coefficient, and a management adaptability index are proposed, providing a quantitative assessment of controllability, performance, and resilience of construction projects.

A recurrent model for the transformation of information-management decisions over time and an integral criterion for management efficiency under recovery conditions are developed. The application of structural-dynamic schemes and dashboard-based models enables the practical implementation of an integrated project management approach. The formulated provisions establish a methodological basis for adaptive management systems aimed at enhancing the resilience and controllability of construction project implementation and recovery processes.

Ключові слова: будівельний проєкт, організаційно-технологічні рішення, інформаційно-управлінські рішення, адаптивне управління, узгодженість рішень, відновлення проєктів, стійкість системи.

Keywords: construction project, organizational-technological decisions, information-management decisions, adaptive management, decision coordination, project recovery, system resilience.

Виклад матеріалу: Сучасна практика реалізації та відновлення будівельних проєктів характеризується зростанням рівня організаційно-технологічної складності, високою динамікою змін зовнішнього середовища та суттєвим зростанням ролі інформаційних потоків у процесах управління. У таких умовах традиційне фрагментарне прийняття рішень, коли технологічні, організаційні та управлінські аспекти розглядаються ізольовано, втрачає ефективність і призводить до зростання ризиків, часових втрат та неузгодженості дій учасників проєкту.

Наукові засади узгодження організаційно-технологічних і інформаційно-управлінських рішень ґрунтуються на системному підході, відповідно до якого будівельний проєкт розглядається як складна відкрита система з ієрархічною структурою, множинними зворотними зв'язками та адаптивними властивостями. У межах такого підходу організаційно-технологічні рішення (послідовність робіт, ресурсомісткість процесів, технологічні режими) та інформаційно-управлінські рішення (планування, координація, моніторинг, коригування) повинні формуватися в єдиному логіко-інформаційному полі [2].

Особливого значення узгодження набуває на етапах відновлення будівельних проєктів, коли система функціонує в умовах підвищеної невизначеності, обмеженості ресурсів та порушеної початкової структури. У таких умовах інформаційно-управлінські рішення виконують не лише регулюючу, а й відновлювальну функцію, забезпечуючи реконфігурацію організаційно-технологічної структури проєкту відповідно до актуальних обмежень і цільових параметрів.

З метою наочної інтерпретації системної логіки взаємодії організаційно-технологічних і інформаційно-управлінських компонентів доцільно представити рисунок 1.

Рис. 1. Логіка узгодження організаційно-технологічних та інформаційно-управлінських рішень у системі реалізації та відновлення будівельних проєктів (розроблено автором на основі [2])

Для систематизації функціональних ролей окремих елементів проєктної системи та виявлення характеру їх взаємозв'язку у процесі узгодження рішень доцільно здійснити структурно-аналітичне зіставлення організаційно-технологічних і інформаційно-управлінських компонентів. Узагальнені результати такого зіставлення наведено у таблиці 1, що дозволяє оцінити їх вплив на керованість, адаптивність і стійкість реалізації та відновлення будівельних проєктів [9].

Таблиця 1.

Взаємозв'язок організаційно-технологічних та інформаційно-управлінських компонентів у системі будівельного проєкту

(розроблено автором на основі [9])

Компонент системи	**Характеристика**	**Роль в узгодженні рішень**	**Очікуваний ефект**
Організаційно-технологічна структура	Сукупність процесів, технологій і ресурсів	Формує базу для управлінських впливів	Раціоналізація виконання робіт
Інформаційні потоки	Дані про стан проєкту та середовище	Забезпечують обґрунтованість рішень	Зменшення невизначеності
Управлінські механізми	Планування, контроль, координація	Інтегрують технологічні та організаційні рішення	Підвищення керованості
Зворотні зв'язки	Оцінка результатів виконання	Ініціюють коригування	Адаптивність системи
Механізми відновлення	Перебудова структури проєкту	Забезпечують стійкість у кризових умовах	Відновлення функціональності

Подальший розвиток наукових засад узгодження організаційно-технологічних і інформаційно-управлінських рішень доцільно спрямовувати на формалізацію взаємозв'язків між структурними елементами проєкту, розроблення кількісних показників інтеграції та побудову моделей адаптивного управління, здатних забезпечити ефективну реалізацію і відновлення будівельних проєктів в умовах динамічної нестабільності.

Реалізація та особливо відновлення будівельних проєктів відбуваються в умовах підвищеної структурної складності, дефіциту ресурсів і нестабільності вихідних даних. За таких умов ефективність проєкту визначається не стільки локальною оптимальністю окремих організаційних або технологічних рішень, скільки рівнем їх системної узгодженості з інформаційно-управлінськими впливами. Це обумовлює необхідність трактування будівельного проєкту як складної адаптивної системи, у якій матеріально-технологічні процеси та управлінські рішення формують єдиний керований контур [12].

З позицій системного аналізу стан будівельного проєкту в момент часу t доцільно описувати через інтеграцію нормованих показників, що характеризують ключові підсистеми: технологічну, ресурсну, інформаційну та управлінську. Такий підхід дозволяє перейти від фрагментарної оцінки окремих параметрів до цілісного уявлення про функціональний стан проєкту. Інтегральний індекс стану системи може бути поданий у вигляді

$$S(t) = w_T T_n(t) + w_R R_n(t) + w_I I_n(t) + w_U U_n(t), (1)$$

де $T_n, R_n, I_n, U_n \in [0;1]$, а вагові коефіцієнти w відображають відносну значущість відповідних контурів.

Для умов реалізації проєкту з елементами відновлення приймемо такі ваги:

$w_T=0,30$, $w_R=0,25$, $w_I=0,20$, $w_U=0,25$.

Нехай за результатами оперативного моніторингу отримано:

1. $T_n=0,72$ (ритмічність і дотримання технологічної послідовності),
2. $R_n=0,64$ (фактична ресурсна забезпеченість),
3. $I_n=0,79$ (актуальність і повнота управлінської інформації),
4. $U_n=0,70$ (ефективність управлінських рішень).

Тоді інтегральний стан системи становить:

$$S(t) = 0,30 \times 0,72 + 0,25 \times 0,64 + 0,20 \times 0,79 + 0,25 \times 0,70 = 0,216 + 0,160 + 0,158 + 0,175 = 0,709.$$

Отримане значення свідчить про відносно стабільний стан системи, однак одночасно фіксує наявність потенційних ризиків, пов'язаних із ресурсним та управлінським контурами, які є критичними для проєктів відновлення.

Подальша деталізація системної взаємодії потребує кількісної оцінки узгодженості рішень. Узгодженість у даному контексті трактується як здатність управлінських рішень забезпечувати мінімальні відхилення між плановими та фактичними параметрами організаційно-технологічної структури. Для цього вводиться коефіцієнт узгодженості [15]:

$$K_u = \sum_{i=1}^{n} w_i \times \frac{1}{1+\Delta_i}, \Delta_i = \left| \frac{x_i^{fact} - x_i^{plan}}{x_i^{plan}} \right|, (2)$$

Розглянемо спрощений, але репрезентативний набір із чотирьох параметрів:

1. тривалість критичних робіт;
2. витрати;
3. продуктивність виконавців;
4. інформаційна затримка прийняття рішень.

Приймаємо ваги: $w_1=0,30$, $w_2=0,25$, $w_3=0,25$, $w_4=0,20$.

За фактичними даними отримано відхилення:

$\Delta_1=0,10$, $\Delta_2=0,08$, $\Delta_3=0,12$, $\Delta_4=0,40$.

Обчислимо нормовані складові:

$$\frac{1}{1+\Delta_1} = 0,91, \frac{1}{1+\Delta_2} = 0,93, \frac{1}{1+\Delta_3} = 0,89, \frac{1}{1+\Delta_4} = 0,71.$$

Тоді коефіцієнт узгодженості дорівнює:

$$K_u = 0{,}30 \times 0{,}91 + 0{,}25 \times 0{,}93 + 0{,}25 \times 0{,}89 + 0{,}20 \times 0{,}71 = 0{,}273 + 0{,}233 + 0{,}223 + 0{,}142 = 0{,}871.$$

Отримане значення K_u=0,87 характеризує достатньо високий рівень узгодження рішень, проте домінуючий внесок інформаційної затримки вказує на наявність прихованого системного ризику, який у відновлювальних проєктах може швидко трансформуватися у технологічні та ресурсні збої [3].

На рисунку 2 подано двоконтурну модель узгодження організаційно-технологічних та інформаційно-управлінських рішень у системі реалізації та відновлення будівельного проєкту, яка відображає логіку керуючого впливу, механізми зворотного зв'язку та формування результатів за параметрами термінів, вартості, якості, стійкості й відновлюваності.

Системна інтерпретація узгодження організаційно-технологічних і інформаційно-управлінських рішень дозволяє формалізувати будівельний проєкт як керовану адаптивну систему з кількісно вимірюваним станом і рівнем інтеграції рішень. Запропоновані показники S(t) та K_u створюють методичну основу для аналізу динаміки управлінських впливів і механізмів адаптації.

У процесі реалізації та відновлення будівельних проєктів інформаційно-управлінські рішення набувають характеру динамічного регулятора, який забезпечує адаптацію організаційно-технологічної структури до змінних умов функціонування. На відміну від стабільних проєктних середовищ, у відновлювальних проєктах управління змушене діяти в умовах неповноти даних, інформаційних лагів та структурних збурень, що обумовлює перехід від директивного планування до реактивно-адаптивного режиму прийняття рішень. У такій системі управлінський вплив формується не лише на основі початкового плану, а як функція поточного стану проєкту, відхилень і прогнозу інерційних процесів.

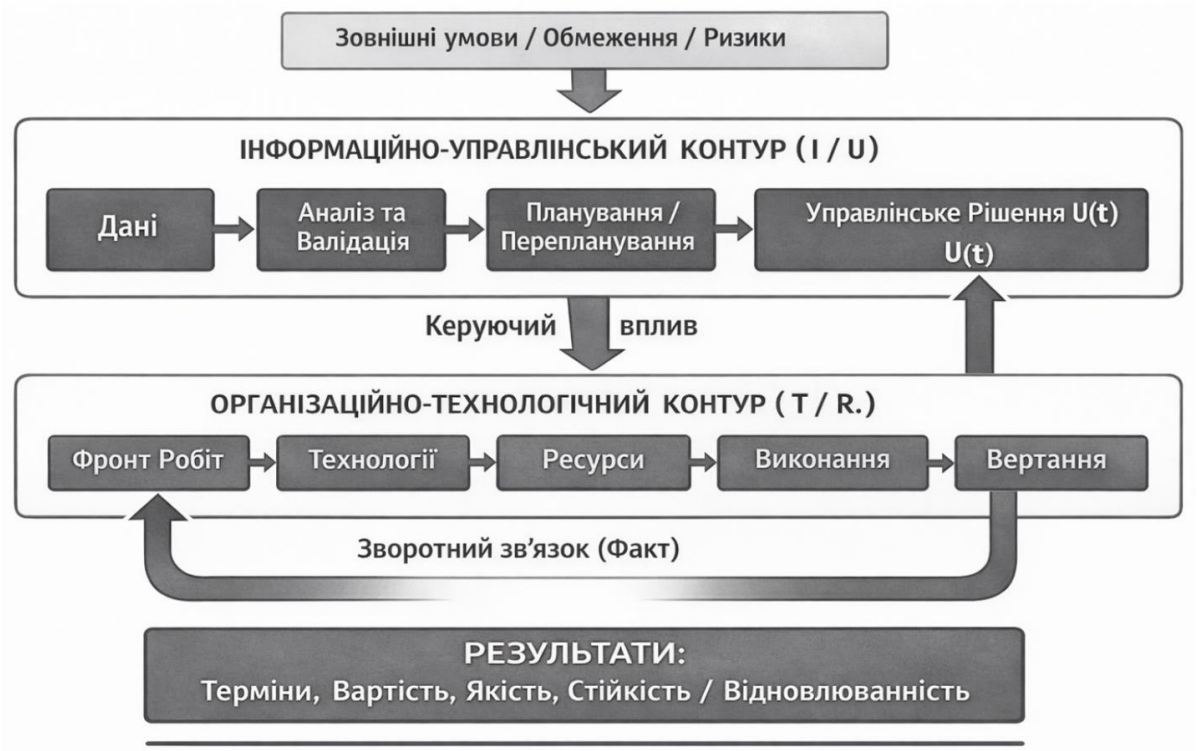

Рис. 2. Двоконтурна модель узгодження організаційно-технологічних та інформаційно-управлінських рішень у системі реалізації та відновлення будівельного проєкту (розроблено автором на основі [3])

Інформаційні потоки, що циркулюють у будівельному проєкті, утворюють багаторівневу структуру, в межах якої первинні дані про виконання робіт, постачання та простої трансформуються в агреговані показники стану, аналітичні оцінки та керуючі команди. Критичною проблемою є те, що управлінські рішення часто базуються на асинхронних або фрагментарних даних, що призводить до запізнілої або надмірної реакції. Тому доцільно формалізувати управлінський вплив через інтегральний показник стану системи S(t), визначений у межах першого питання, та цільовий рівень S_c, який задає допустиму зону функціонування проєкту.

Процес трансформації управлінських рішень у часі може бути описаний рекурентною моделлю коригування:

$$U(t+1) = U(t) + \alpha \times \big(S_c - S(t)\big), \quad (3)$$

де U(t) – рівень управлінського впливу в момент часу t, α – коефіцієнт реактивності управління, S_c – цільовий стан системи. Для відновлювальних проєктів значення α зазвичай перебуває в межах 0,25–0,40, що забезпечує достатню швидкість реагування без виникнення перерегулювання.

Нехай початкове значення управлінського впливу становить U(0)=0,70, цільовий стан системи – S_c=0,80, а коефіцієнт реактивності дорівнює α=0,35. За результатами моніторингу інтегральний стан системи протягом чотирьох послідовних періодів змінюється так: S(0)=0,709, S(1)=0,735, S(2)=0,760, S(3)=0,785. Тоді послідовні значення управлінського впливу визначаються як

$$U(1) = 0{,}70 + 0{,}35(0{,}80 - 0{,}709) = 0{,}7319,$$

$$U(2) = 0{,}7319 + 0{,}35(0{,}80 - 0{,}735) = 0{,}75465,$$

$$U(3) = 0{,}75465 + 0{,}35(0{,}80 - 0{,}760) = 0{,}76865,$$
$$U(4) = 0{,}76865 + 0{,}35(0{,}80 - 0{,}785) = 0{,}77390.$$

Отримана динаміка свідчить про поступове посилення управлінського впливу зі спадною інкрементною складовою, що відповідає керованому входженню системи в зону цільового функціонування без різких стрибків управління [14].

Важливою характеристикою якості управління є не лише абсолютний рівень впливу, а й його чутливість до змін стану системи. Для цього вводиться індекс адаптивності управління:

$$A = \frac{1}{m}\sum_{j=1}^{m}\left|\frac{\Delta U_j}{\Delta S_j}\right|, \qquad (4)$$

де ΔU_j та ΔS_j – зміни управлінського впливу та стану системи на j-му інтервалі. На основі наведених даних отримаємо для чотирьох інтервалів послідовні значення відношень $|\Delta U/\Delta S|$: 1,23, 0,91, 0,56 та 0,53. Середнє значення індексу адаптивності становить

$$A = \frac{1{,}23 + 0{,}91 + 0{,}56 + 0{,}53}{4} = 0{,}81.$$

Таке значення індексу характеризує управління як достатньо чутливе на початкових етапах відновлення з поступовим зниженням інтенсивності реакції в міру стабілізації стану системи, що є бажаним для складних організаційно-технологічних систем.

На рисунку 3 подано структурно-динамічну схему формування та трансформації інформаційно-управлінських рішень у будівельному проєкті, яка відображає послідовність переходу від збору та валідації даних до реалізації управлінських впливів в організаційно-технологічному контурі із замкненими зворотними зв'язками.

На рисунку 4 наведено динаміку зближення інтегрального стану будівельного проєкту з цільовим рівнем та еволюцію управлінського впливу в часі, що ілюструє керований адаптивний характер управління в процесі реалізації та відновлення проєкту [8].

Так, механізми формування та трансформації інформаційно-управлінських рішень у будівельних проєктах доцільно розглядати як замкнений адаптивний цикл, у якому управлінський вплив кількісно пов'язаний зі станом організаційно-технологічної системи та коригується відповідно до заданого цільового рівня. Запропоновані рекурентна модель управління та індекс адаптивності створюють аналітичну основу для подальшої інтеграції управлінських і технологічних рішень та переходу до оцінювання ефективності й стійкості системи в умовах невизначеності.

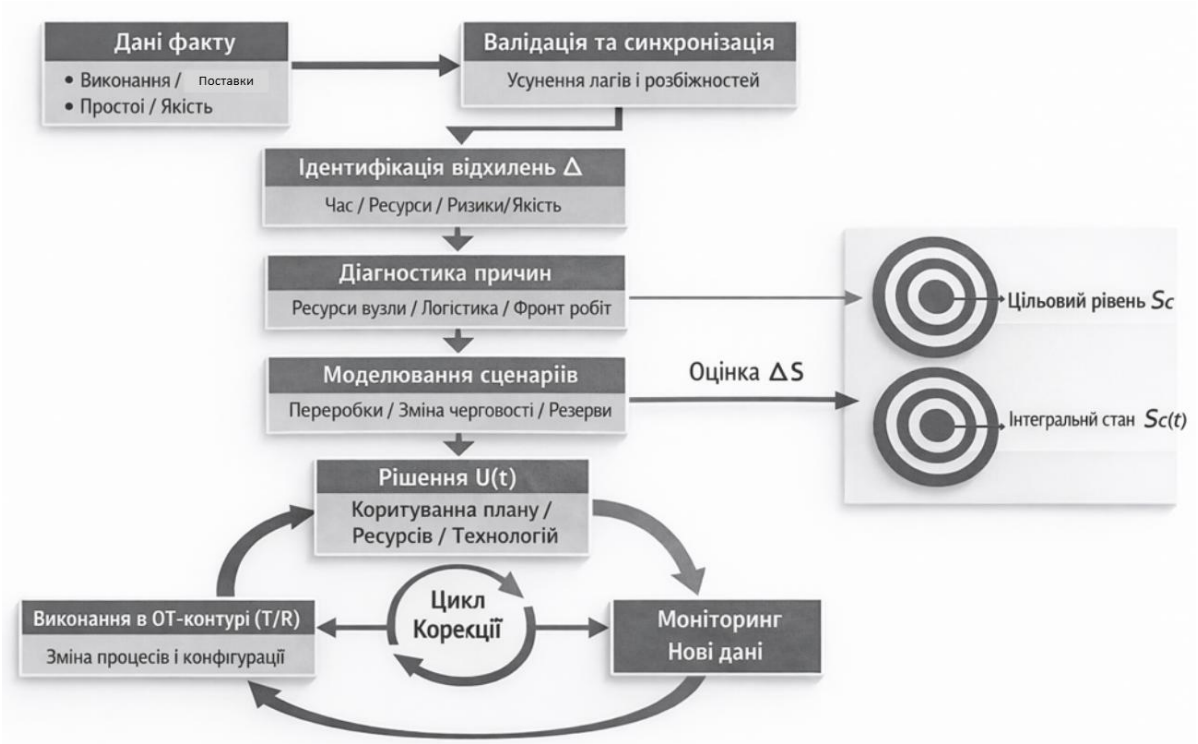

Рис. 3. Структурно-динамічна схема формування та трансформації інформаційно-управлінських рішень у будівельному проєкті (розроблено автором на основі [14])

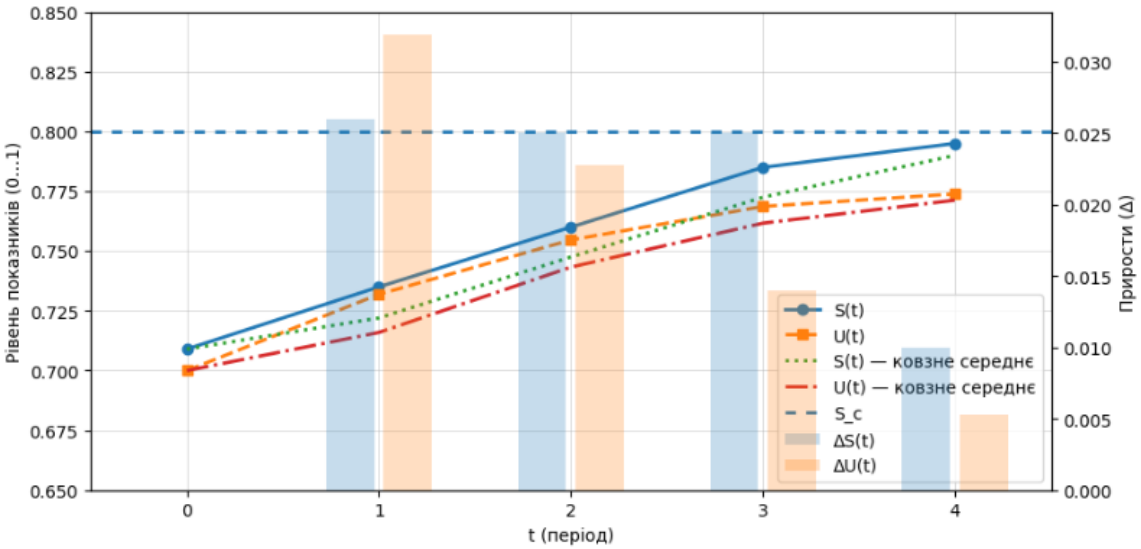

Рис. 4. Динаміка зближення інтегрального стану будівельного проєкту з цільовим рівнем та еволюція управлінського впливу (розроблено автором на основі [8])

Інтеграція організаційно-технологічних і інформаційно-управлінських рішень у будівельних проєктах відновлення є завершальним етапом формування цілісної системи управління, орієнтованої на стійкість, керованість і досягнення цільових параметрів за умов нестабільності [15]. На відміну від фаз планової реалізації, відновлення потребує не лише синхронізації рішень, а й їх методично обґрунтованого поєднання в єдину інтегральну модель, здатну одночасно враховувати технологічні обмеження, ресурсні збої, інформаційні лаги та управлінську інерційність.

У методичному сенсі інтеграцію доцільно розглядати як процес узгодженого формування керуючих впливів, у якому показники узгодженості K_u та адаптивності A (визначені у попередніх питаннях) поєднуються в єдиний інтегральний критерій ефективності управління [1]. Такий критерій дозволяє перейти від якісного опису “керованості” проєкту до кількісної оцінки результативності інтегрованого управління в конкретний момент часу.

Інтегральний показник ефективності управління в умовах відновлення може бути поданий у вигляді зваженої композиції:

$$E = \sum_{k=1}^{p} \beta_k \times K_{uk} \times A_k, \qquad (5)$$

де K_{uk} – коефіцієнт узгодженості за k-м управлінським контуром (час, ресурси, якість, інформація), A_k – відповідний індекс адаптивності, β_k – вагові коефіцієнти, що відображають пріоритети проєкту, $\sum\beta_k=1$.

Для ілюстрації застосування показника розглянемо спрощений варіант із чотирьох контурів: часовий, ресурсний, якісний та інформаційно-управлінський. Приймемо ваги $\beta_1=0{,}30$, $\beta_2=0{,}25$, $\beta_3=0{,}20$, $\beta_4=0{,}25$. За результатами попередніх розрахунків і моніторингу отримаємо:

$$Ku = \{0{,}88;\ 0{,}84;\ 0{,}78;\ 0{,}87\},$$

$$A = \{0{,}82;\ 0{,}79;\ 0{,}75;\ 0{,}81\}.$$

Тоді:

$$\begin{aligned} E = {} & 0{,}30 \times 0{,}88 \times 0{,}82 + 0{,}25 \times 0{,}84 \times 0{,}79 \\ & + 0{,}20 \times 0{,}78 \times 0{,}75 \\ & + 0{,}25 \times 0{,}87 \times 0{,}81 \\ & = 0{,}216 + 0{,}166 + 0{,}117 + 0{,}176 \\ & = 0{,}675. \end{aligned}$$

Отримане значення E=0,675 свідчить про середньо-високий рівень ефективності інтегрованого управління, при якому система вже є керованою, але зберігає потенціал для підвищення результативності за рахунок поліпшення узгодженості та адаптивності в окремих контурах [10].

Для оцінювання здатності проєкту зберігати керованість після порушень або кризових збурень доцільно вводити індекс стійкості відновлення, який порівнює ефективність інтегрованого управління до та після реалізації відновлювальних заходів:

$$R_s = \frac{E_{\text{відн}}}{E_{\text{баз}}}, \qquad (6)$$

Нехай базовий рівень ефективності до порушення становив $E_{\text{баз}}=0{,}60$, а після реалізації інтегрованих управлінських і технологічних коригувань отримано $E_{\text{відн}}=0{,}675$. Тоді

$$R_s = \frac{0{,}675}{0{,}60} = 1{,}125.$$

Значення Rs>1 інтерпретується як підвищення стійкості системи внаслідок інтеграції рішень, що підтверджує доцільність застосування комплексного підходу саме для проєктів відновлення [5].

Практична реалізація інтегрованого управління потребує наочних інструментів підтримки

прийняття рішень, серед яких особливе місце займають дашбордні моделі. Вони дозволяють одночасно відображати стан організаційно-технологічної структури, рівень узгодженості рішень, адаптивність управління та інтегральну ефективність, забезпечуючи зменшення інформаційного лага між фактичним станом проєкту та управлінською реакцією [7].

Для наочного відображення результатів інтеграції організаційно-технологічних і інформаційно-управлінських рішень у процесі відновлення будівельного проєкту доцільно використати рисунок 5, який забезпечує синхронізоване представлення ключових показників стану системи та ефективності управління.

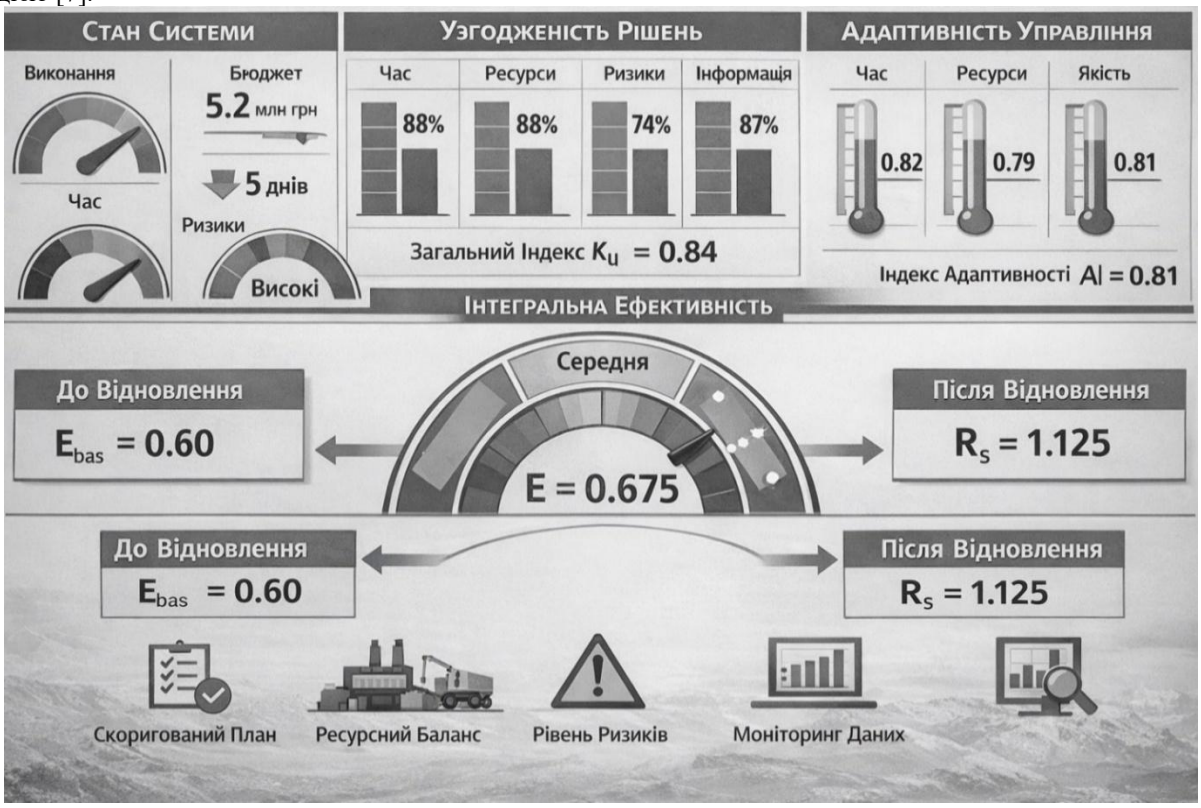

Рис. 5. Дашбордна модель інтегрованого управління організаційно-технологічною та інформаційно-управлінською системою будівельного проєкту в умовах відновлення (розроблено автором на основі [5])

На рисунку 6 наведено концептуальну модель інтеграції організаційно-технологічних і інформаційно-управлінських рішень, що відображає логіку взаємодії технологічних процесів, управлінських впливів і зворотних зв'язків у системі реалізації та відновлення будівельних проєктів [6].

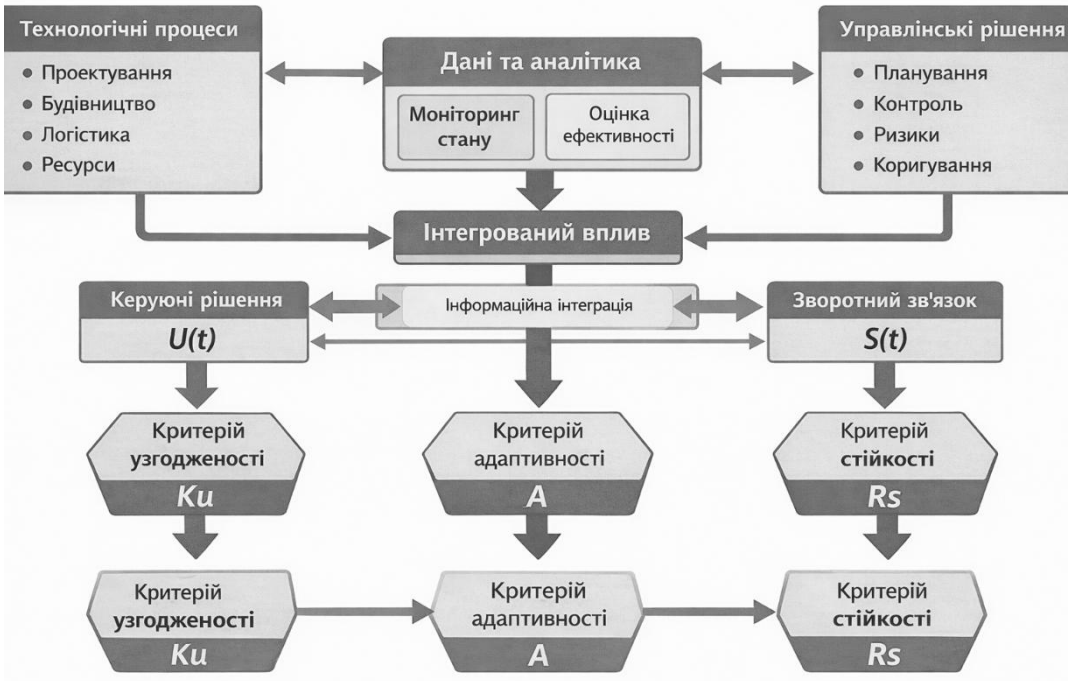

Рис. 6. Концептуальна модель інтеграції організаційно-технологічних і інформаційно-управлінських рішень (розроблено автором на основі [6])

Для узагальнення результатів інтеграції організаційно-технологічних та інформаційно-управлінських рішень, а також для забезпечення цілісного сприйняття розрахункових показників ефективності та стійкості управління, доцільно звести ключові індикатори в єдину аналітичну форму. Це дозволяє систематизувати взаємозв'язок між окремими характеристиками узгодженості, адаптивності та результативності управління, а також визначити їх функціональну роль у процесах реалізації та відновлення будівельного проєкту [4]. Саме з цією метою нижче наведено таблицю 2, що відображає логіку переходу від локальних управлінських характеристик до комплексної оцінки стійкості системи.

Таблиця 2.

Узагальнені показники інтеграції та стійкості управління будівельним проєктом *(розроблено автором на основі [4])*

Показник	Змістовна інтерпретація	Формула	Роль у відновленні
K_u	Узгодженість рішень	(2)	Синхронізація плану і факту
A	Адаптивність управління	(4)	Швидкість реакції
E	Інтегральна ефективність	(5)	Результативність управління
R_s	Стійкість відновлення	(6)	Порівняльна оцінка до/після

Методичні підходи до інтеграції організаційно-технологічних та інформаційно-управлінських рішень дозволяють сформувати кількісно обґрунтовану модель керування будівельними проєктами в умовах невизначеності та відновлення. Запропоновані інтегральні показники ефективності й стійкості, у поєднанні з дашбордною візуалізацією, створюють основу для практичного впровадження адаптивного управління.

Доцільно зазначити, що реалізація та відновлення будівельних проєктів у сучасних умовах потребують переосмислення традиційних підходів до організації та управління виробничими процесами.

Зростання організаційно-технологічної складності, динамічність зовнішнього середовища та високий рівень невизначеності зумовлюють необхідність переходу від фрагментарного прийняття рішень до цілісного системного управління, у межах якого технологічні, ресурсні та інформаційно-управлінські компоненти розглядаються як взаємопов'язані елементи єдиної адаптивної системи.

Розгляд будівельного проєкту як складної керованої системи дозволив сформувати формалізоване уявлення про його стан і виявити визначальну роль узгодженості рішень між організаційно-технологічним та управлінським контурами. Введення інтегральних показників стану та узгодженості створює можливість кількісної оцінки керованості проєкту й ідентифікації критичних зон, у яких навіть незначні відхилення здатні трансформуватися у системні ризики, особливо на етапах відновлення [11].

Аналіз механізмів формування та трансформації інформаційно-управлінських рішень показав, що ефективне управління в умовах нестабільності повинно мати динамічний, реактивно-адаптивний характер. Управлінський вплив у такій системі не є сталим, а змінюється залежно від поточного стану

проєкту та швидкості його наближення до цільових параметрів. Формалізація цих процесів дозволяє оцінювати не лише інтенсивність управління, а й його адаптивність, що є критично важливим для запобігання надмірним коливанням і втраті керованості.

Інтеграція організаційно-технологічних та інформаційно-управлінських рішень у межах єдиного методичного підходу дала змогу перейти до комплексної оцінки ефективності та стійкості будівельного проєкту. Використання інтегральних критеріїв дозволяє порівнювати різні управлінські стани системи, оцінювати результативність відновлювальних заходів і обґрунтовувати управлінські рішення на основі кількісних показників, а не інтуїтивних оцінок.

Загалом сформований підхід забезпечує науково обґрунтовану основу для побудови адаптивної системи управління будівельними проєктами, здатної ефективно функціонувати в умовах невизначеності та структурних збурень. Отримані теоретичні положення, розрахункові моделі та інструменти візуалізації створюють передумови для подальшого розвитку прикладних методів управління, спрямованих на підвищення стійкості, керованості та результативності процесів реалізації й відновлення будівельних систем.

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